mercruiser

SERVICE MANUAL

Number 3

MARINE ENGINES

Mercury Marine 4 Cylinder
GM 4 Cylinder • GM 6 Cylinder
GM V-8 Cylinder

Book 1 of 2

Sections 1 thru 4

©Brunswick Corporation 1988

Printed in U.S.A.

90-95693 1-888

MODELS COVERED IN THIS MANUAL

MODEL	SERIAL NUMBER
MCM 120	4952701 - 6255465
MCM 120R	6255466 - 6853913
MCM 140	4918570 - 6256954
MCM 140R	6256955 - 6852269
MCM 165	4884835 and Above
MCM 470	4886620 - 6218036
MCM 470R	6218037 - 6902287
MCM 485	5685394 and Above
MCM 488R	6170297 - 6899057
MCM 898	4887830 - 6218461
MCM 898R	6218462 - 6899057
MCM 228	4902305 - 6225266
MCM 228R	6225267 - 6899268
MCM 260	4908850 - 6227756
MCM 260R	6227757 - 6890705
MCM 330	4889680 - 6083144
MCM 330 (B-W)	6083145 - 6920831
MCM 370/400	4883520 - 6721534
MCM 400 Cyclone	5669232 - 6844266
MCM 440 Cyclone	6181070 - OA429860
MCM 460 Cyclone	6180970 - 6181039
MCM 475 Turbo	5670797 and Below
MCM 470TR	All (Note 1)
MCM 230TR	6901029 and Below (Note 1)
MCM 260TR	6885891 and Below (Note 1)
MIE 470	All
MIE 228	4931100 - 5907057
MIE 230	5907058 - 6901029
MIE 255	4924565 - 5907057
MIE 260	5907058 - 6885891
MIE 330	4890180 - 5889913
MIE 340	5889914 - OA307952

Note 1: Refer to top of page 1A-13.

NOTICE

Refer to appropriate "Stern Drive Service Manual" for Transom Assembly and Stern Drive Unit Repair.

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SERVICE MANUAL OUTLINE

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- Part C - Troubleshooting

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- Part B - MCM 120R/140R Driveshaft Extension Models
- Part C - MCM 470/485/488
- Part D - MCM 898/228/260
- Part E - MCM 898/228/260 Driveshaft Extension Models
- Part F - MCM 330TR/TRS with Mercury Marine Transmission
- Part G - MCM 330 (B-W) TR/TRS
- Part H - MCM 370/400TRS and Hi-Performance Engines
- Part I - MIE 470/228/230/255/260/330/340

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- Part A - Seawater Cooled Models
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- Part A - Velvet Drive (Borg-Warner) Transmission
- Part B - Mercury Marine Transmission
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SECTION 9 - Power Steering System

NOTICE

Throughout this publication, "Dangers", "Warnings" and "Cautions" (outlined in a border and accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. —— OBSERVE THEM CAREFULLY!

These "Safety Alerts" alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus "common sense" operation, are major accident prevention measures.

⚠ DANGER

DANGER — Immediate hazards which WILL result in severe personal injury or death.

⚠ WARNING

WARNING — Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠ CAUTION

CAUTION — Hazards or unsafe practices which could result in minor personal injury or product or property damage.

NOTICE TO USERS OF THIS MANUAL

This service manual has been written and published by the service department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system is capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. (Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

(OVER)

REPLACEMENT PARTS

⚠WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

ENGINE MECHANICAL COMPONENTS

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts will void the warranty on those parts which are damaged as a result of the use of other than recommended parts.

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MERCURY MARINE
A BRUNSWICK COMPANY

merCruiser
STERN DRIVES & INBOARDS

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INTRODUCTION

This comprehensive overhaul and repair manual is designed as a "Service Guide" for MerCruiser models listed. It provides specific information including procedures for disassembly, assembly, inspection and adjustment, to enable dealers and service mechanics to keep the MerCruiser in top operating condition. The procedures are supplemented with photos and illustrations.

Before attempting particular repairs, it is suggested that the repair procedure first be read thru completely to gain a total picture of the repair method, cautions and warnings.

PROPELLER INFORMATION

For in-depth information on marine propellers and boat performance -- written by marine engineers -- order "Everything You Should Know About Propellers" Part No. 90-86144.

HI-PERFORMANCE BOATING

For a booklet entitled "Hi-Performance Boat Operation" -- written by marine engineers -- order Part No. 90-86168.

HOW TO USE THIS MANUAL

The manual is divided into SECTIONS (shown, right) which represent major components and systems.

Some SECTIONS are further divided into PARTS. Each PART has a title page. An index for the particular PART is printed on the back of the title page.

SECTIONS and PARTS are listed on the "Service Manual Outline" sheet which immediately follows the cover of this book.

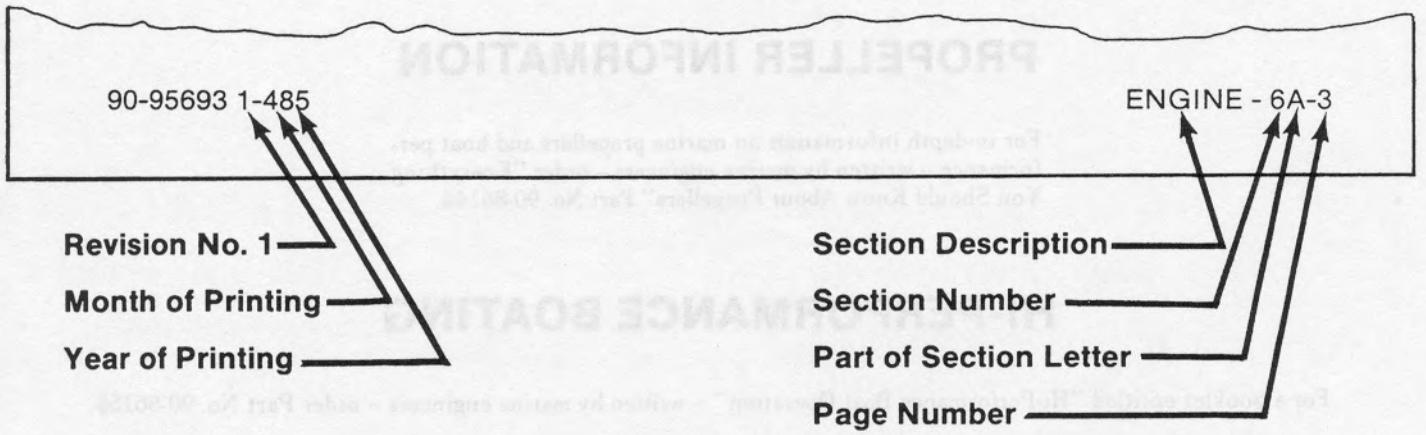
For Transom Assembly and Stern Drive Unit repair, refer to appropriate "Stern Drive Service Manual".

Section	Section Heading
1	General Information/Troubleshooting
2	Removal/Installation/Alignment
3	Electrical Systems
4	Fuel Systems
5	Exhaust Systems
6	Engine
7	Cooling Systems
8	Drive Systems
9	Power Steering System

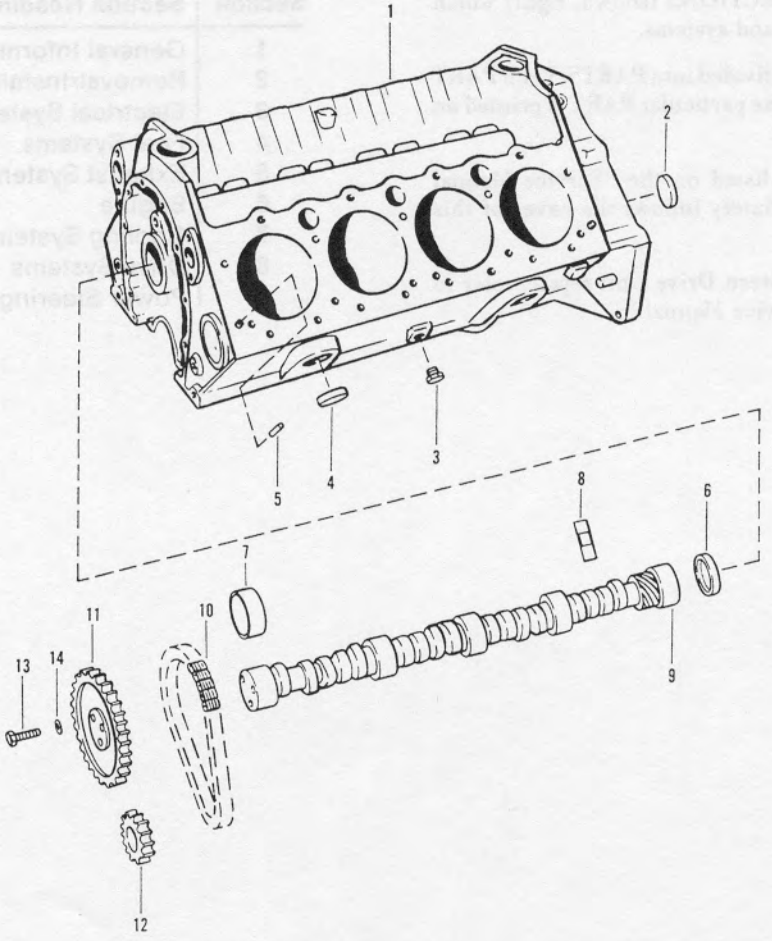
PAGE NUMBERING

Two number groups appear at the bottom of each page. The example, below, is self-explanatory.

EXAMPLE:



HOW TO READ PARTS MANUAL



CYLINDER BLOCK AND CAMSHAFT (260R/MR)

M0033-D8

PART NO.	REF. NO.	DESCRIPTION	QUAN.
841-8163	1	CYLINDER BLOCK ASSEMBLY	1
N.S.S.	2	PLUG, expansion (1-1/4") (GM #3738306)	2
22-87238	3	DRAIN COCK, cylinder block	2
19-34270	4	PLUG, expansion - cylinder block (1-5/8" Diameter)	8
17-35465	5	PIN, dowel - block to head (5/16" Diameter)	4
22-72640	6	PLUG, expansion - camshaft bearing hole	1
23-85674	7	BEARING UNIT, camshaft (set)	1
72638	8	LIFTER, hydraulic valve	16
431-5943	9	CAMSHAFT	1
35378	10	CHAIN, camshaft timing	1
43-35338	11	SPROCKET, camshaft timing	1
43-48338	12	SPROCKET, crankshaft timing	1
10-34505	13	BOLT, camshaft timing sprockets (3/4")	3
12-39167	14	WASHER, camshaft timing sprocket bolt	3

841-8163 Cylinder Block Assembly includes only standard pistons, piston rings, crankshaft bearings and camshaft bearings.

A. **Part Number:** For part ordering - Note N.S.S. for Reference Number 2, Plug, expansion - that means Not Sold Separately by Mercury Marine, however, in this case, the G.M. Part Number (for the plug) is given in the Description Column.

B. **Reference Number:** For part shown on exploded parts view.

C. **Description:** This is the most important column because it gives:
   1) Description of Part: Ref. No. 1 is a Cylinder Block Assembly, No. 9 is a Camshaft, etc.
   2) What parts are included with a certain part: Notice how the Description of Part, for Ref. Nos. 1 and 8 thru 14, are at the left side of the column. Description of Part for Ref. Nos. 2 thru 7 are indented under "Cylinder Block Assembly". If Ref. No. 1 (Cylinder Block Assembly) was ordered, all indented parts (Ref. Nos. 2 thru 7) would come with the part. Ref. Nos. 8 thru 14 would not come with Ref. No. 1 and would have to be ordered separately. If 2 Cylinder Blocks were listed, both cylinder blocks would come with the indented parts. In some cases, an indented part will have another part indented under it. The second indented part will come with the first indented part.
   3) Serial number break: If serial number information is listed, check product serial number to ensure that correct part is ordered.
   4) Special information: Many times special information will be shown after description such as; L.H. Rotation, R.H. Rotation, Filter Up, Filter Down, etc. This will help in selecting the correct part.

D. **Quantity:** Quantity that has to be ordered.

E. **Special Information Block:** Additional information, part numbers for gasket sets, etc.

DIRECTIONAL REFERENCES

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this service manual, all directional references are given as they appear when viewing boat from stern, looking toward bow, except on V-Drive inboard engines. (Figure 1)

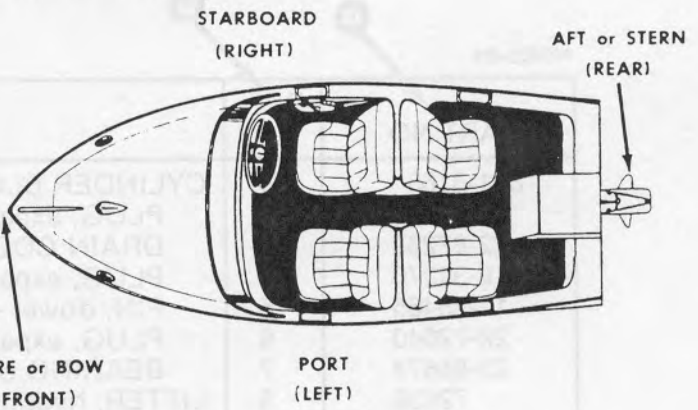


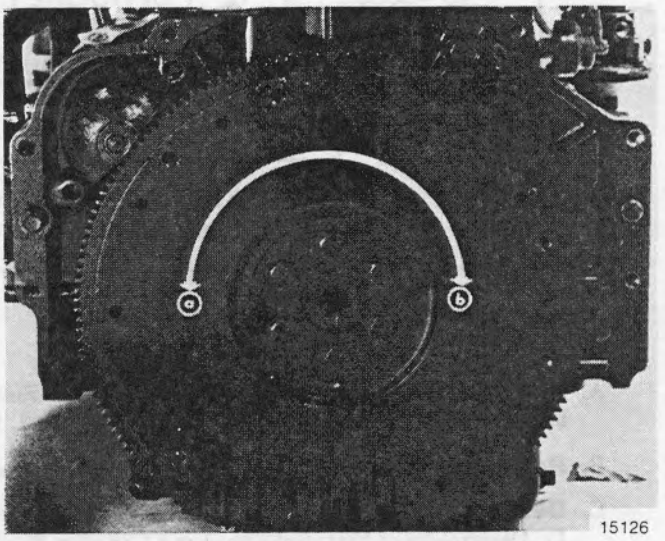
Figure 1. Directional Reference

ENGINE ROTATION

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



a - Left Hand Rotation (CCW) - All MCM Stern Drive Engines, MIE Inboard L.H. (Standard) Rotation
b - Right Hand Rotation (CW) - MIE Inboard R.H. (Opposite) Rotation

Figure 1. Engine Rotation

ENGINE 20-HOUR BREAK-IN PERIOD

IMPORTANT: Proper break-in is essential to obtaining minimum oil consumption, maximum engine performance and service.

The first 20 hours of operation is the engine (new or rebuilt) break-in period. During this period, it is extremely important that the engine is operated, as outlined in the following information.

1. DO NOT operate engine below 1500 RPM for extended periods of time during the first 10 hours. During this period, shift into gear as soon as possible after starting engine and advance throttle so that RPM is above 1500 (provided that conditions permit safe operation at this speed).
2. DO NOT operate at any one constant speed for extended periods of time.
3. DO NOT exceed ¾ of full throttle during the first 10 hours of operation. During the next 10 hours, occasional operation at full throttle (5 minutes at-a-time maximum) is permissible.
4. AVOID full throttle acceleration from stopped position.
5. DO NOT operate at full throttle until engine reaches normal operating temperature.
6. OBSERVE INSTRUMENTATION carefully. If an abnormal reading occurs, stop engine immediately and determine cause.
7. FREQUENTLY CHECK crankcase oil level and add oil if necessary. It is normal for oil consumption to be somewhat high during the break-in period.
8. At end of 20-hour break-in period, drain break-in oil from crankcase and replace oil filter. Fill crankcase with correct grade and viscosity oil.

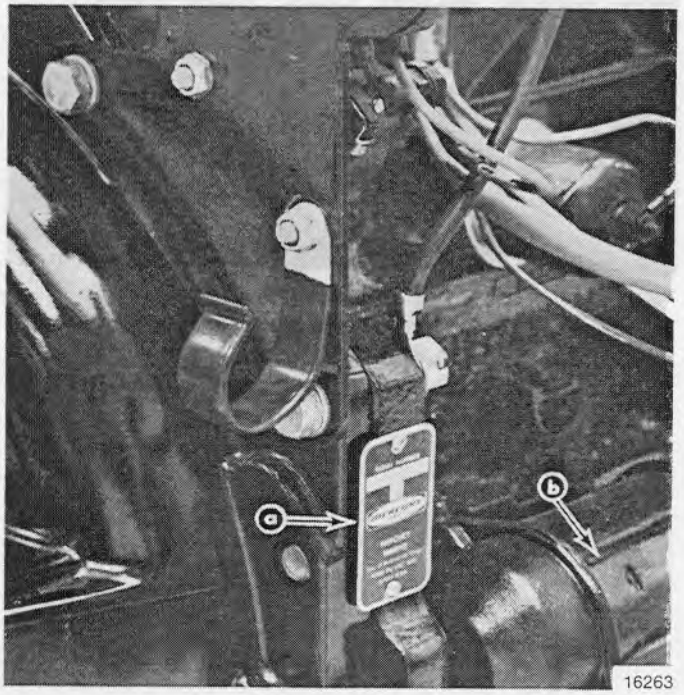
WATER TESTING NEW MERCRUISER ENGINES

Care must be exercised during the first 20 hours of operation on new MerCruisers or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

1. Start engine and run at idle RPM until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine RPM (in 200 RPM increments) until engine reaches its maximum rated RPM.

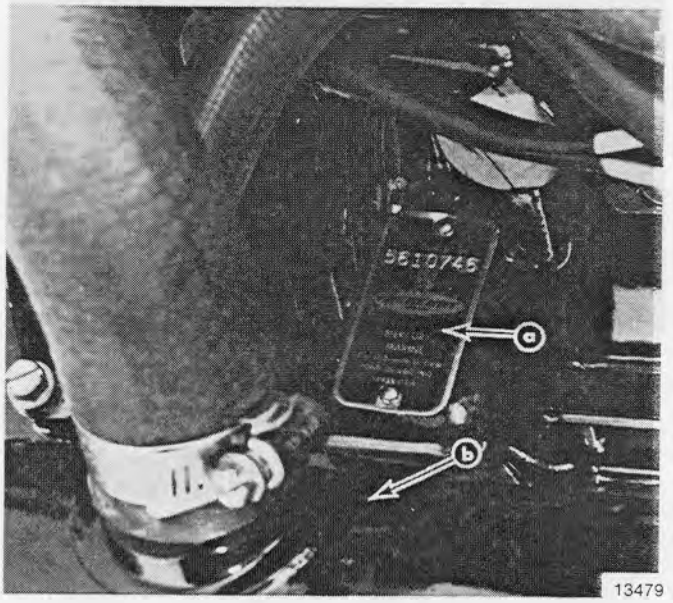
IMPORTANT: DO NOT run at maximum RPM for more than 2 minutes.

SERIAL NUMBER LOCATIONS



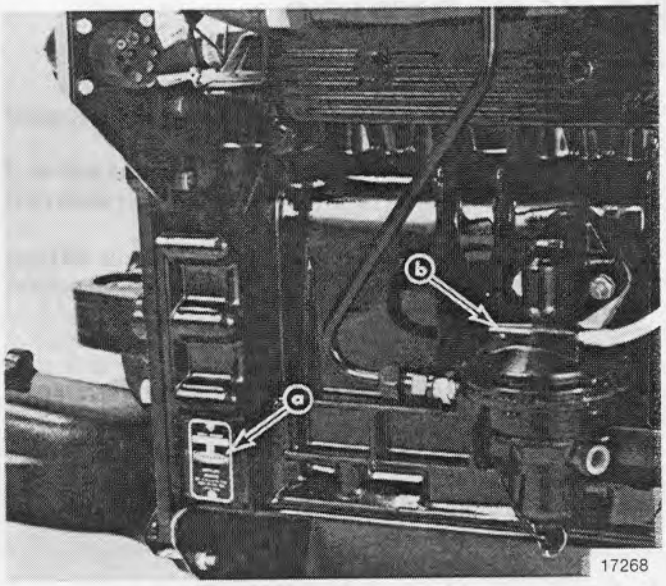
a - Serial Number Plate
b - Starter Motor

Figure 1. MCM 120/120R/140/140R/165



a - Serial Number Plate
b - Front of Heat Exchanger

Figure 2. MCM 470/485 and Early MCM 470R/488R

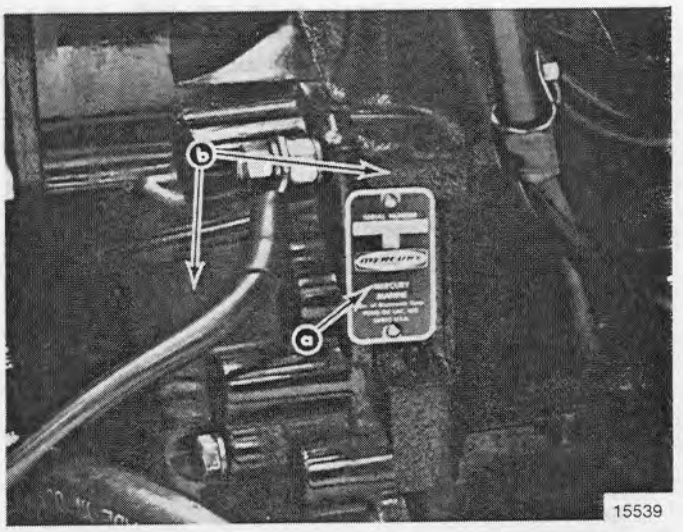


a - Serial Number Plate
b - Fuel Pump

Figure 3. Later MCM 470R/488R

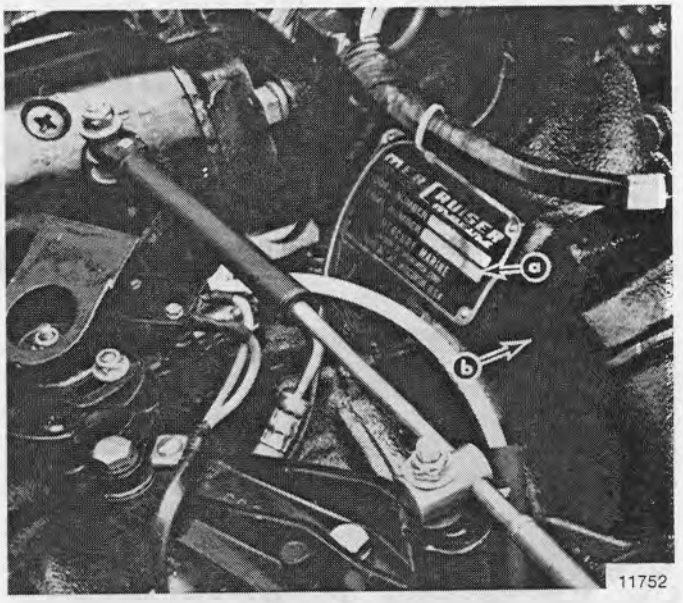
a - Serial Number Plate
b - Starter Motor

Figure 4. MCM 898/898R/228/228R/260/260R/330



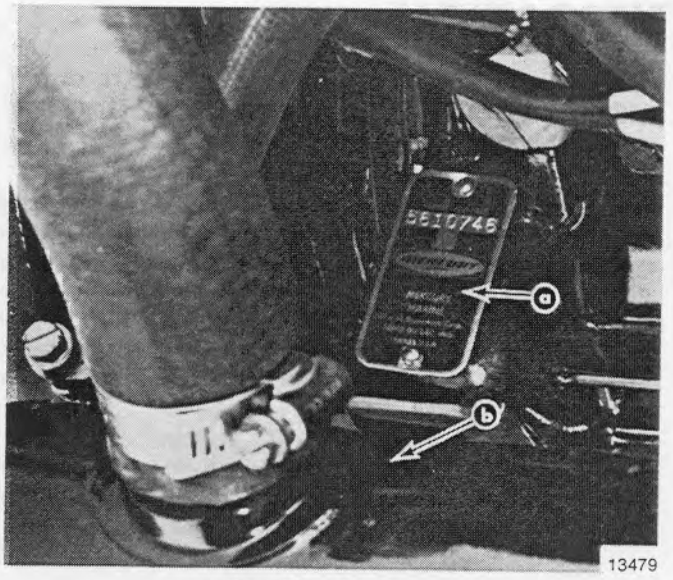
a - Serial Number Plate
b - Starboard Side of Flywheel Bell Housing and Cylinder Block

Figure 5. MCM 330 (B-W)



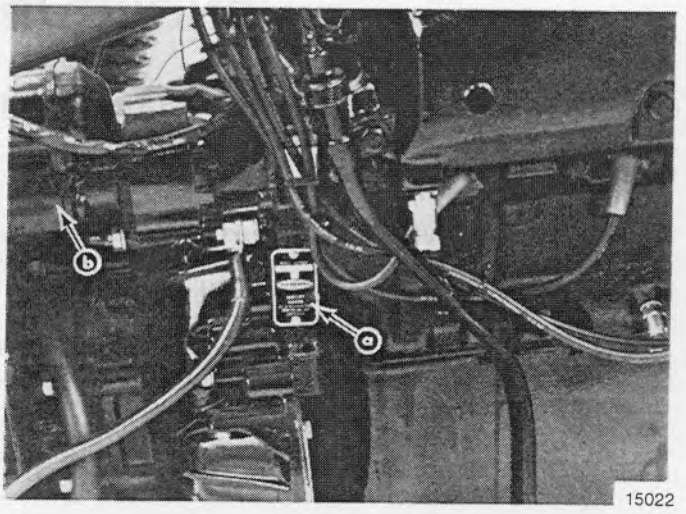
a - Serial Number Plate
b - Flywheel Bell Housing

Figure 6. MCM 370/400/400 Cyclone/440 Cyclone/460 Cyclone/475 Turbo and MCM 470TR/230TR/260TR



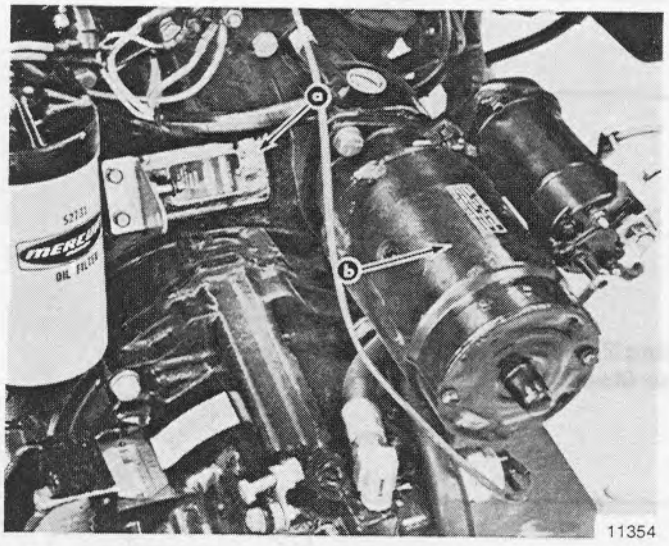
a - Serial Number Plate
b - Front of Heat Exchanger

Figure 7. MIE 470



a - Serial Number Plate
b - Starter Motor

Figure 9. MIE 230/260/340



a - Serial Number Plate
b - Starter Motor

Figure 8. MIE 228/255/330

ENGINE IDENTIFICATION

MCM 120R-thru-260R ENGINES and TRANSOM ASSEMBLIES INCOMPATIBLE WITH OLD MODELS

The MCM 120R-thru-260R engines and transom assemblies cannot be used to replace previous (older) MCM 120-thru-260 engines and transom assemblies for the following reasons:

- Engine mounting hole center-to-center dimension is different in flywheel housing and inner transom plate.
  MCM 120R-thru-260R - 9-1/2" (241mm)
  MCM 120-thru-485 - 14-1/2" (368mm)
  MCM 898-thru-260 - 12-1/2" (318mm)
- Exhaust collector systems are not interchangeable between the "R" models and the previous models.

USE OF OLDER MODEL STERN DRIVE UNITS ON MCM 120R-thru-260R MODELS

Mercury Marine does not recommend the use of older model stern drive units on the new models, as the units will not mate up satisfactorily with the transom assembly. In addition, the older in-line model stern drive units are equipped with universal joint coupling end yoke (39385A1). (Figure 1) This yoke is shorter than yoke (59830A1) (Figure 2) used on the new model stern drive units, and therefore, will not fully engage the engine coupler splines.

IMPORTANT: Use of an older in-line model stern drive unit on a new model will result in a spline failure to coupling and/or yoke.

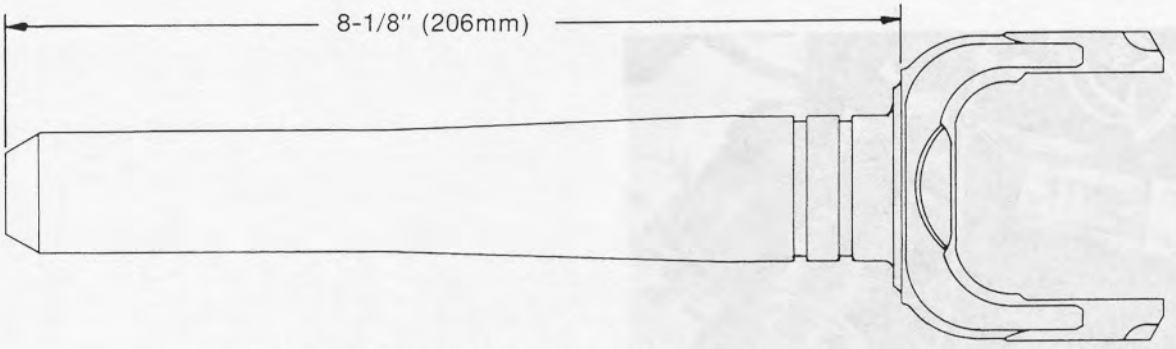


Figure 1. Universal Joint Coupling End Yoke (39385A1) Used On Older In-Line Models

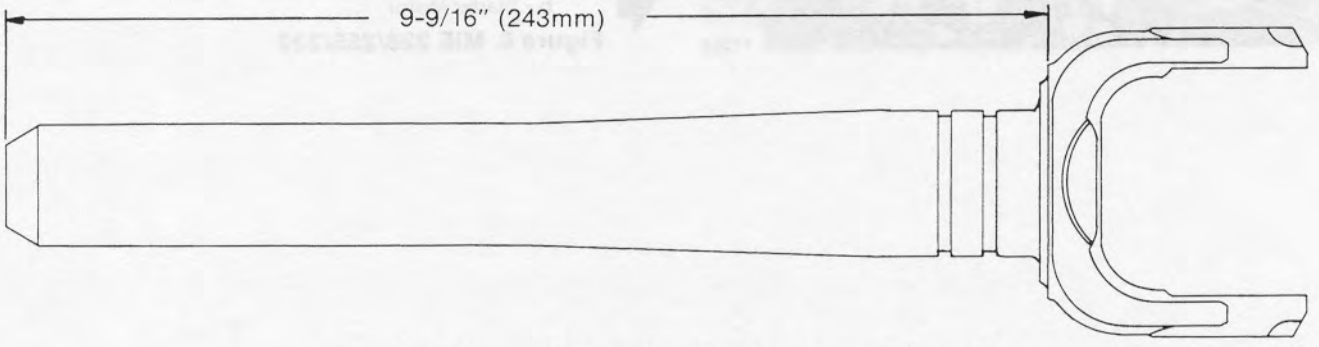
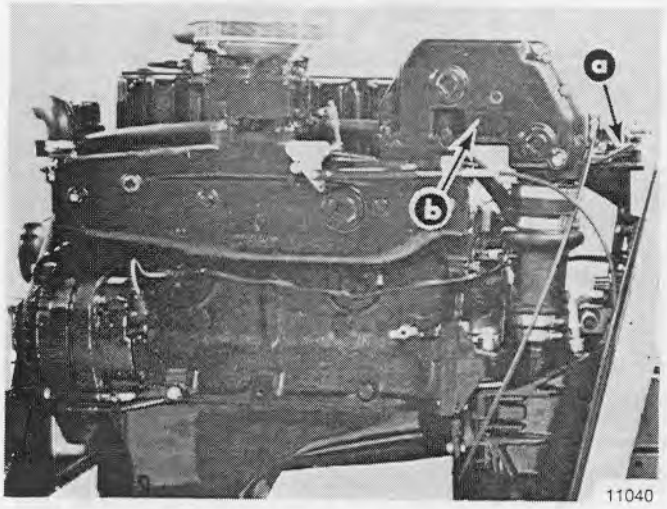
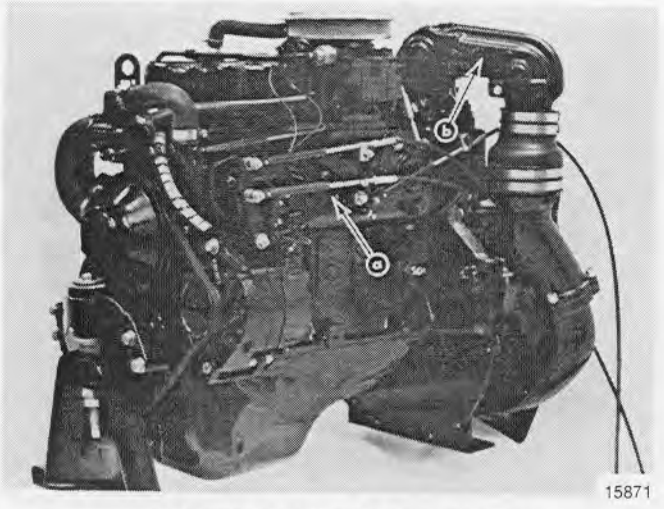


Figure 2. Universal Joint Coupling End Yoke (59830A1) Used On MerCruiser MCM 120R-thru-260R Models and Older V-8 Models



a - Shift Plate On Inner Transom Plate
b - Straight-Back Exhaust Elbow

Figure 3. MCM 120/140



a - Shift Plate On Side of Exhaust Manifold
b - Off-Set Exhaust Elbow

Figure 4. MCM 120R/140R

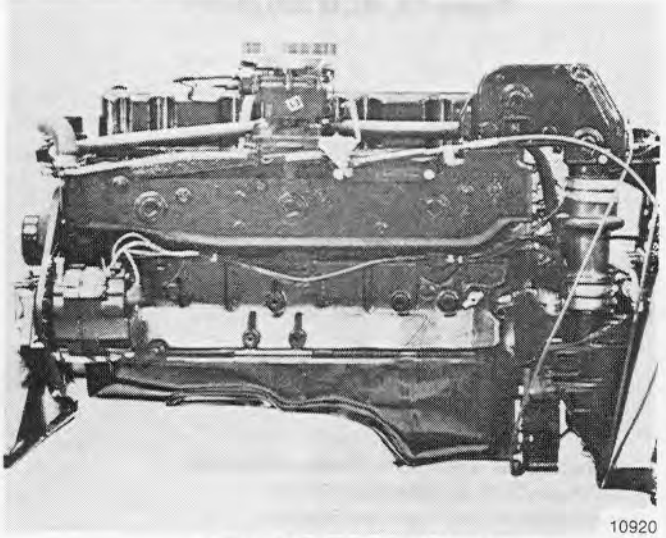
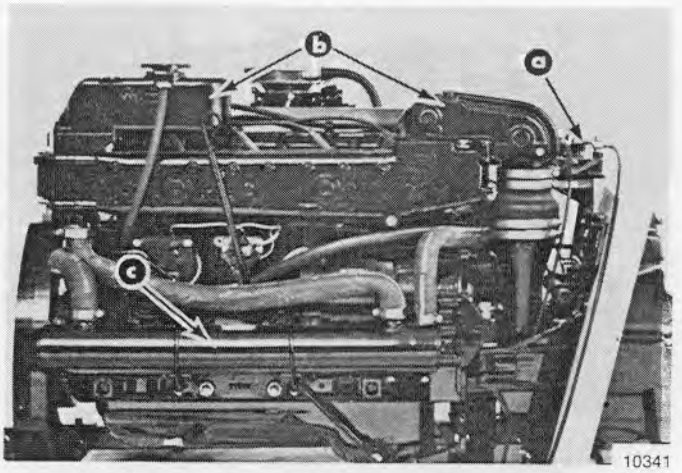
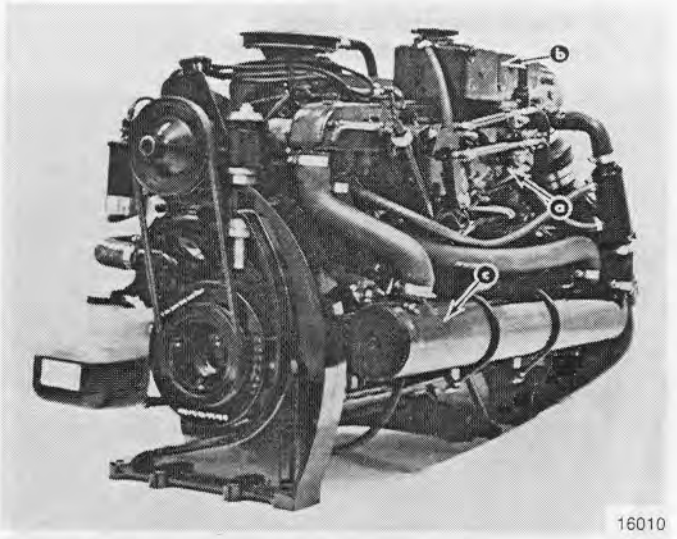


Figure 5. MCM 165



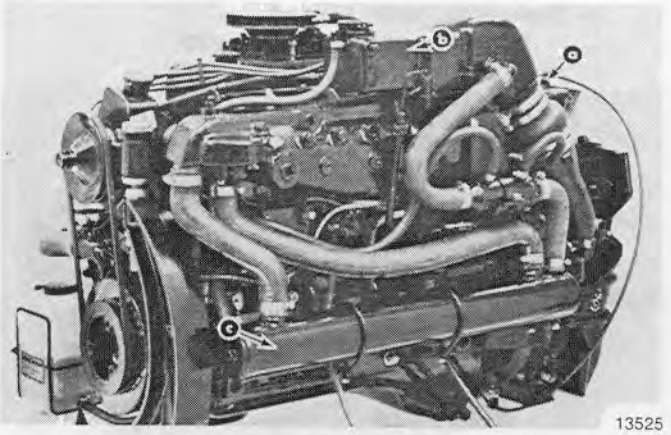
a - Shift Plate Mounted On Inner Transom Plate
b - Separate Coolant Reservoir and Exhaust Elbow
c - 3" (76mm) Heat Exchanger

Figure 6. MCM 470



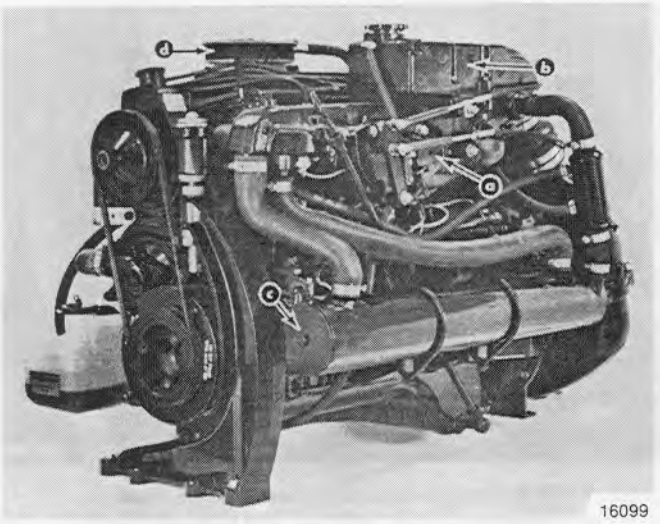
a - Shift Plate On Side of Exhaust Manifold
b - Combined Coolant Reservoir and Exhaust Elbow
c - 4" (102mm) Heat Exchanger

Figure 7. MCM 470R



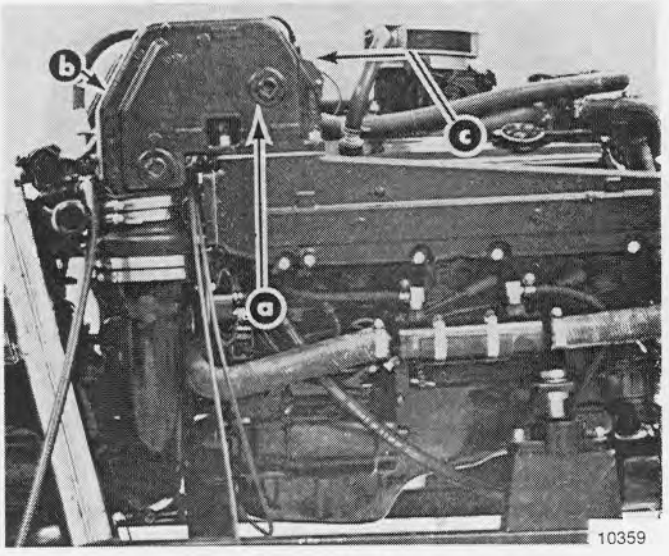
a - Shift Plate Mounted on Inner Transom Plate
b - Combined Coolant Reservoir and Exhaust Elbow
c - 3" (76mm) Heat Exchanger

Figure 8. MCM 485



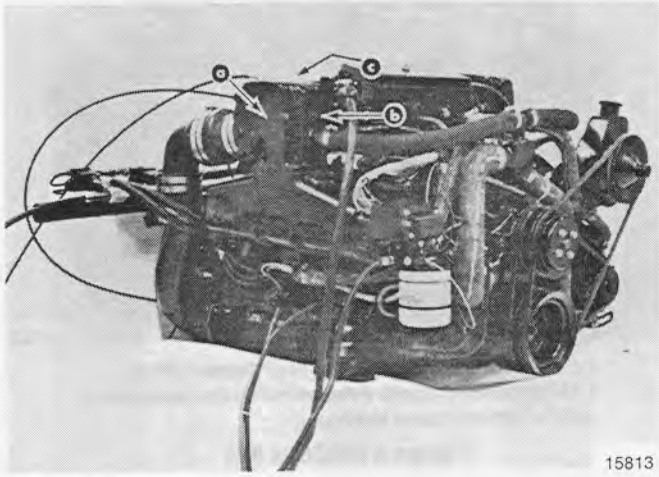
a - Shift Plate Mounted on Side of Exhaust Manifold
b - Combined Coolant Reservoir and Exhaust Elbow
c - 4" (102mm) Heat Exchanger
d - 4 Barrel Rochester Carburetor

Figure 9. MCM 488R



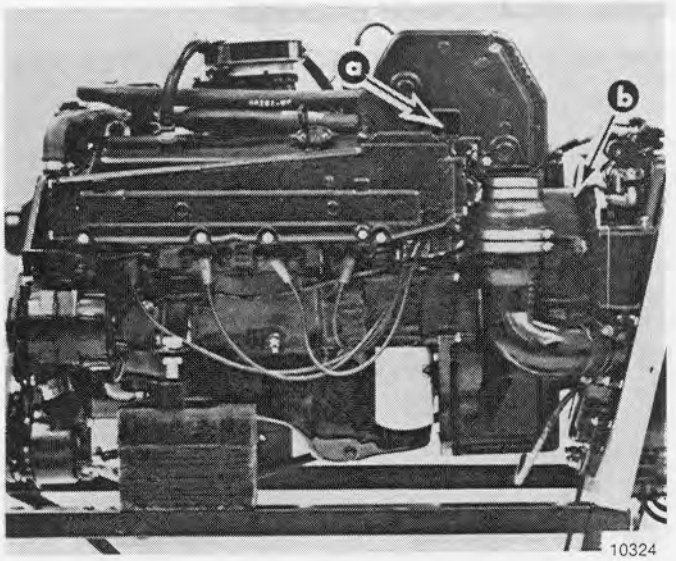
a - Exhaust Elbow Mounted On Aft End of Manifold
b - Shift Plate At Back of Engine
c - Conventional Ignition System

Figure 10. MCM 898/228/260



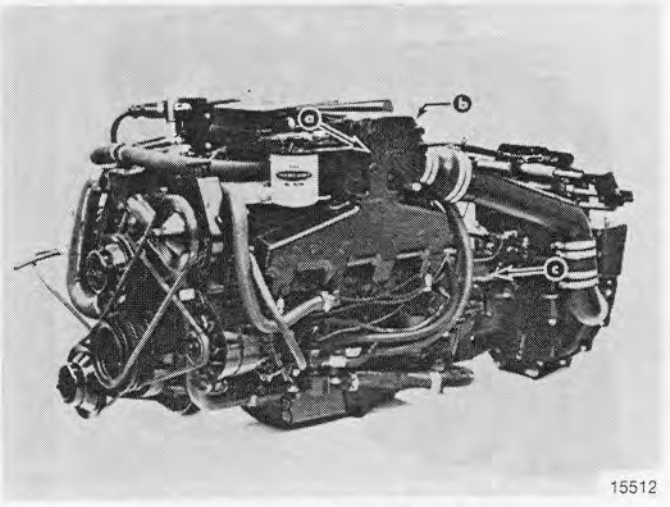
a - Exhaust Elbow Mounted In Center of Manifold
b - Shift Plate On Side of Exhaust Elbow
c - Thunderbolt IV (HEI) Ignition System

Figure 11. MCM 898R/228R/260R



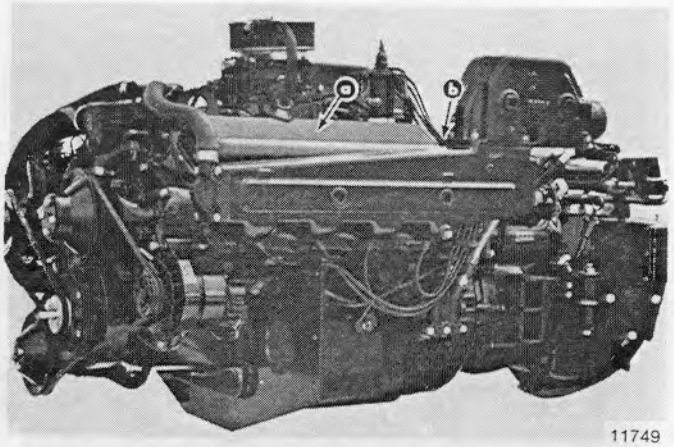
a - Exhaust Elbow Mounted On Aft End of Manifold
b - Mercury Marine Transmission

Figure 12. MCM 330



a - Exhaust Elbow Mounted In Center of Manifold
b - Thunderbolt IV (HEI) Ignition System
c - Borg-Warner Transmission

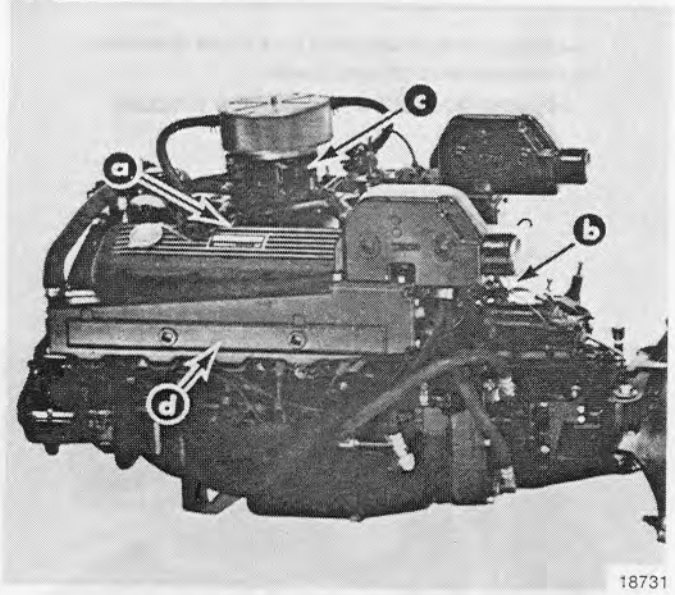
Figure 13. MCM 330 (B-W)



11749

a - Rocker Arm Cover Decal - "370" or "Series 400"
b - Serial Number Plate on Flywheel Housing - "370" Stamped in Plate

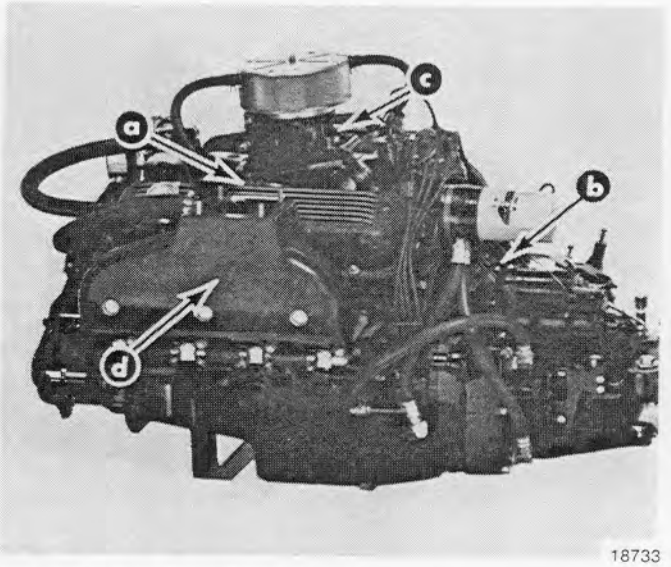
Figure 14. MCM 370/400



18731

a - Rocker Arm Cover Decal - "400"
b - Serial Number Plate on Flywheel Housing - "400" Stamped in Plate
c - Rochester 4 Barrel Carburetor
d - 370 Type Exhaust Manifold and Elbow

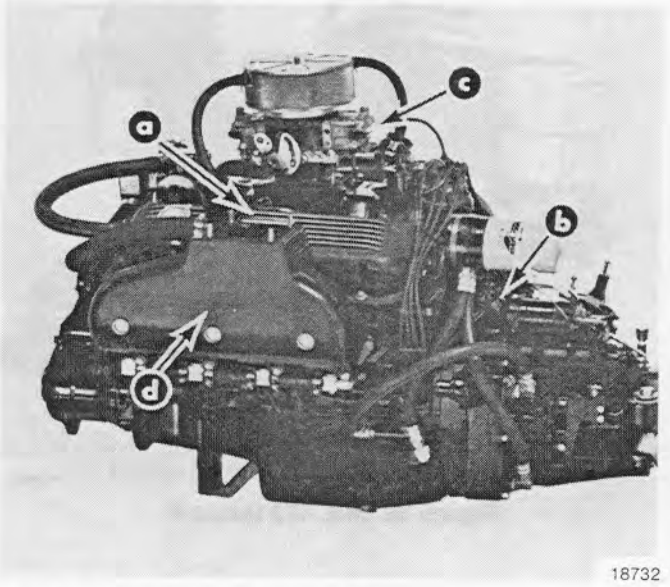
Figure 15. MCM 400 Cyclone



18733

a - Rocker Arm Cover Decal - "440"
b - Serial Number Plate on Flywheel Housing - "440" Stamped in Plate
c - Early Models Had Rochester 4 Barrel Carburetor, Later Models Had Holley 4 Barrel Carburetor
d - Center Outlet Type Exhaust Manifold

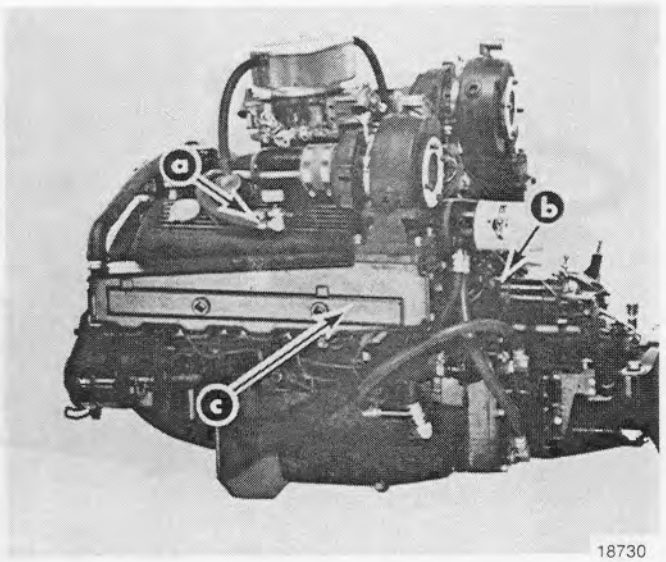
Figure 16. MCM 440 Cyclone



18732

a - Rocker Arm Cover Decal - "460"
b - Serial Number Plate on Flywheel Housing - "460" Stamped in Plate
c - Holley 4 Barrel Carburetor
d - Center Outlet Type Exhaust Manifold

Figure 17. MCM 460 Cyclone



a - Rocker Arm Cover Decal - "475"
b - Serial Number Plate on Flywheel Housing - "475" Stamped in Plate
c - 370 Type Exhaust Manifold with Turbo

Figure 18. MCM 475 Turbo

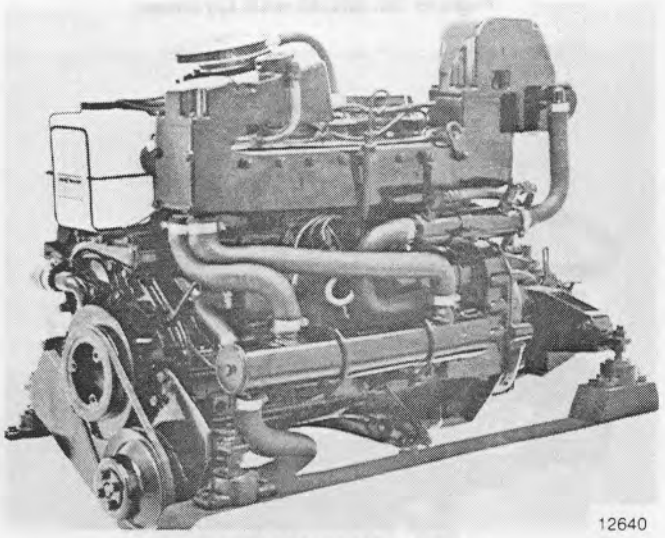
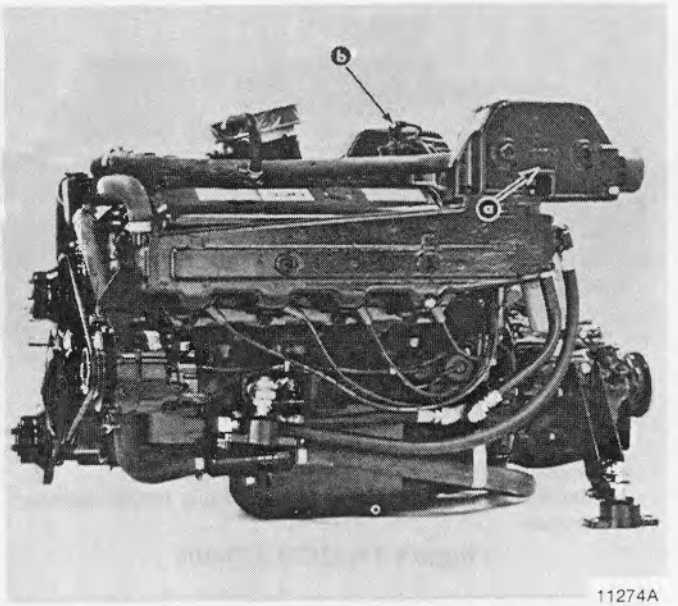
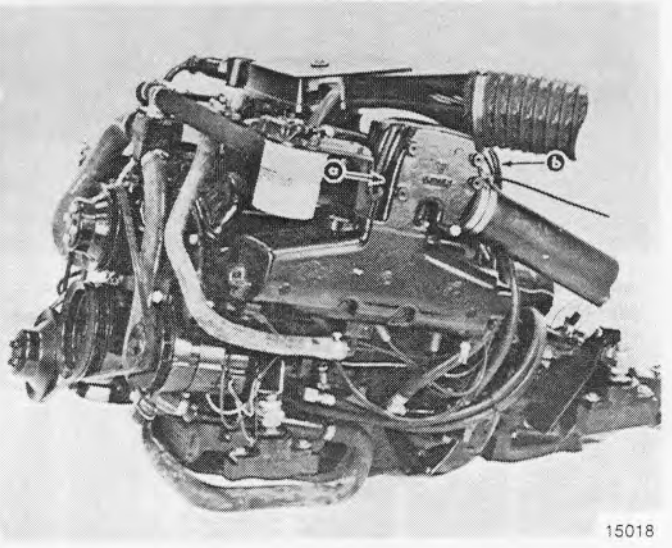


Figure 19. MIE 470 Inboard



a - Exhaust Elbow Mounted on Aft End of Manifold
b - Conventional Ignition System

Figure 20. MIE 228/255/330 Inboard



a - Exhaust Elbow Mounted In Center of Manifold
b - Thunderbolt IV (HEI) Ignition System

Figure 21. MIE 230/260/340 Inboard

MCM 470TR/230TR/260TR

Mercury Marine Hi-Performance Products has built three TR Production Performance Power Packages. "Removal, Installation and Alignment" are similar to the MCM 330 (B-W) in "Section 2, Part G". For transmission and tailstock repair, refer to "Section 8, Part A".

MCM 470TR: MIE 470 (L.H.) inboard engine with a Borg-Warner transmission (for TR package) added to engine. Limited production. Repair and specifications for engine is the same as MIE 470.

MCM 230TR: MIE 230 (L.H.) inboard engine with a Borg-Warner transmission (for TR package) added to engine. Repair and specifications for engine is the same as MIE 230.

MCM 260TR: MIE 260 (L.H.) inboard engine with a Borg-Warner transmission (for TR package) added to engine. Repair and specifications for engine is the same as MIE 260.

BOAT and ENGINE PERFORMANCE

NOTICE
For further information, order "Everything You Need To Know About Propellers" (P/N 90-86144) from:
Mercury Marine
Attn: Publications Department
1939 Pioneer Road
Fond du Lac, WI 54935 U.S.A.

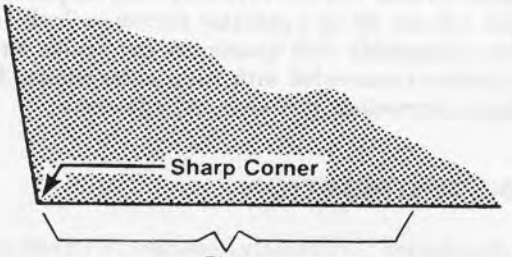


Figure 1

BOAT BOTTOM

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5m) (Figure 1). For best speed and minimum spray the corner between the bottom and the transom should be sharp.

The bottom is referred to as having a "hook" if it is concave in the fore-and-aft direction (Figure 2). A "hook" causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed, but it helps planing and reduces any porpoising (rythmical bouncing) tendency. A slight "hook" is often built in by the manufacturer. A "hook" can also be caused by not trailering or storing the boat with support directly under the transom.

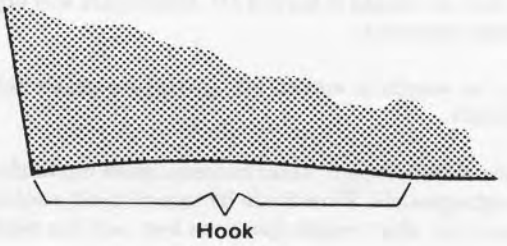


Figure 2

A "rocker" is the reverse of a "hook" (Figure 3). The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.

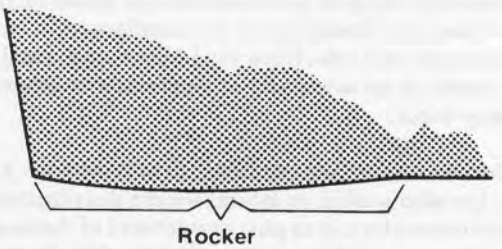


Figure 3

Any "hook", "rocker" or surface roughness on the bottom, particularly in the all-important center-aft portion (Figure 4), will have a negative effect on speed, often several miles per hour on a fast boat.

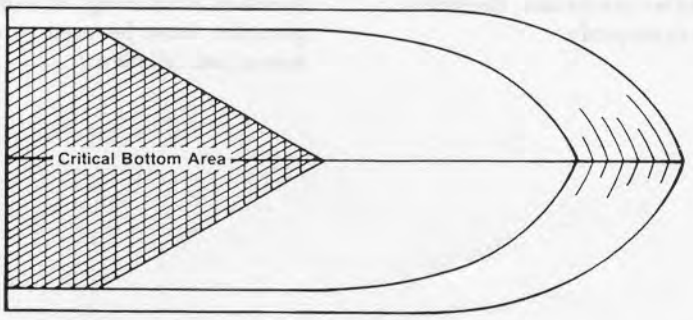


Figure 4

Marine Fouling

Fouling is a kind of unwanted buildup (usually animal-vegetable-derived) occurring on the boat's bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic buildup of material quickly. So it's important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Special hull treatments, such as antifouling paint, will reduce the rate of bottom fouling. However, due to the fact that drive units (outboard or stern drive) are made primarily of aluminum, be sure to select an antifouling paint having a copper-free, organo-tin base. The BIS (Tri-Butyl-Tin) Adipate (TBTA) base paint will not set up a galvanic corrosion "cell" as it is completely compatible with aluminum and avoids any electrolysis problems connected with many other paints. Applied according to instruction, it is also very effective.

WEIGHT DISTRIBUTION

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight — gear and passengers — should be as far aft as possible, to allow the bow to come up to a more efficient angle (3° to 5°). But on the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water In Boat

When a boat has lost performance, the bilge should be checked for water. Water weighs approximately 8 lbs. (29kg) per 1 gal. (3.8 litres) and can add considerable weight to a boat, thereby causing a loss of performance.

Because hulls are constructed with stringers and cross members, each separate area can hold water. Most boat manufactures have drain holes to drain out the water. Make sure these drain holes are open.

PROPELLERS

Pitch is the distance that a propeller would move in one revolution (if it were traveling through a soft solid - like a screw in wood).

Diameter is the distance across the circle made by the blade tips as the propeller rotates.

When a propeller is identified as 13 x 21, it has a 13″ diameter with 21″ of pitch. Theoretically, the propeller would move forward 21″ in one revolution.

Stern Drive Propeller Selection

⚠CAUTION

If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will "labor" and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Quicksilver propeller, for stern drives, cannot be bought in different diameters for a certain pitch, material and style. Example; a 19″ pitch aluminum Black Max propeller comes only with a 14″ diameter.

It is the responsibility of the boat manufacturer and/or selling dealer to equip stern drive unit with the correct propeller. The correct propeller will allow the engine to operate within the specified RPM range at wide-open-throttle (WOT). Correct propeller must be used to obtain maximum engine performance and efficiency.

Because of many variables of boat design, only testing will determine the best propeller for a particular application.

To test if the correct propeller has been installed, operate boat (with average load onboard) at WOT and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that, under a heavy load, engine speed will not fall below specifications. If engine speed is too high, replace propeller with one that has a higher pitch. If engine speed is too low, replace with a lower pitch propeller. Normally, a 300 to 400 RPM change exists between propeller pitches.

Inboard Propeller Selection

⚠CAUTION

If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will "labor" and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Inboard propellers are made in many different styles. Unlike stern drive propellers, inboard propellers can be bought in different diameters for a certain pitch, material and style. They also come with or without a cup.

Changing diameter, pitch or cupping will have an effect on engine speed and prop slip, and in turn, directly effect the performance of a boat. The blade configuration of a propeller is also important. Two 11" x 12" propellers from different propeller manufacturers may perform quite differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller. The correct propeller will allow the engine to operate within the specified RPM range at wide-open-throttle (WOT). Correct propeller must be used to obtain maximum engine performance and efficiency.

Because of many variables of boat design, only testing will determine the best propeller for a particular application.

To test if the correct propeller has been installed, operate boat (with average load onboard) at WOT and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that, under a heavy load, engine speed will not fall below specifications. If the engine exceeds the recommended RPM, an increase in pitch and/or diameter is required. A decrease in pitch and/or diameter is called for if engine RPM is too low. Normally a 1" change in pitch or diameter will change engine speed by 150 RPM. Cupping a propeller usually will reduce engine RPM by approximately 200 RPM.

ELEVATION and CLIMATE

Elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air, like using a supercharger in reverse. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is propped out on a cool, dry day in spring and later, on a hot, sultry day in August, doesn't have its old zip. (See HP/weather relationship chart, Figure 5.)

Although some performance can be regained by dropping to a lower-pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change (to stern drive unit) to more reduction is possible and very beneficial.

It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.

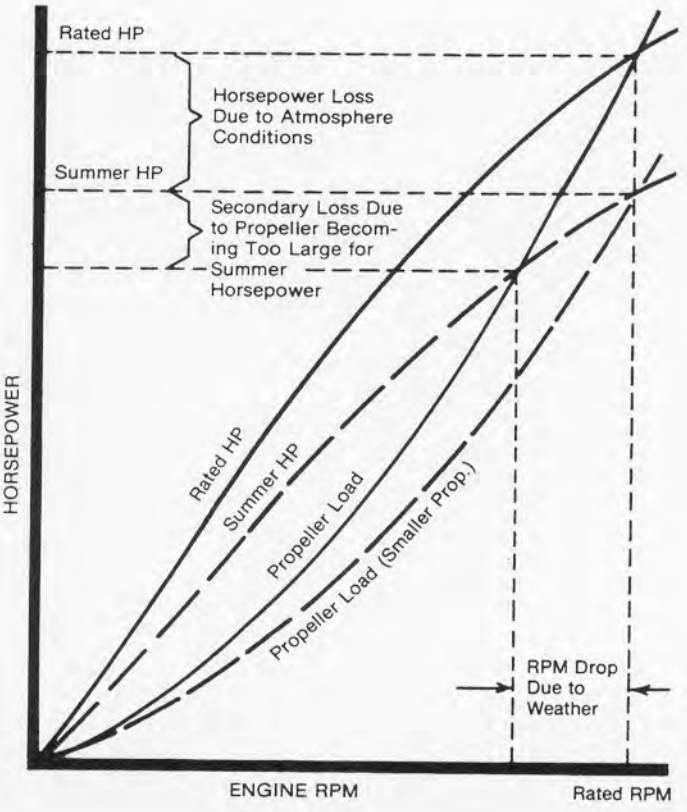


Figure 5.

SECTION 1 - IMPORTANT INFORMATION/ TROUBLESHOOTING

PART B - MAINTENANCE

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year
e Crankcase Oil - Check level	●				
ed Cooling Models Only - Check coolant level	●				
emote Control and Steering System - Check for proper operation	●				■
Power Package (Entire) - Observe for obvious leaks (water, fuel, oil, exhaust, etc.)		■		Refer to Page 00	●
Ignition System - Check timing and adjust, if necessary			●		●
Crankcase Oil and Oil Filter - Change			●	●	
Power Steering Models Only - Check fluid level (A)			●		■ Note 1
Power Package (Entire) - Carefully inspect for leaks (water, coolant, fuel, oil, fluid and exhaust)			■		
Cooling System Hose Clamps - Check tightness; clean and test pressure cap			■		
Engine Exhaust Bellows Clamps - Check tightness			■		
Drive Belts (All) - Inspect condition and check nsion.					
n System - Clean and inspect condition					
ackage (Entire) - Check for loose, parts, (especially engine d starter,					

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STERN DRIVES & INBOARDS

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NOTICE

Refer to appropriate "Stern Drive Service Manual" for all transom plate and stern drive maintenance.

MCM 120-260 MAINTENANCE SCHEDULE

• = To Be Performed by Owner ■ = To Be Performed by an Authorized MerCruiser Dealer

NOTE: Refer to the end of this chart for explanation of lettered references (A, B, etc.) and "NOTES".

⚠WARNING

Always disconnect battery cables from battery BEFORE working around electrical system components to prevent injury to yourself or damage to electrical system should a wire be accidentally shorted.

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year
Engine Crankcase Oil - Check level	•				
Closed Cooling Models Only - Check coolant level	•				
Remote Control and Steering System - Check for proper operation	•			■	
Power Package (Entire) - Observe for obvious leaks (water, fuel, oil, exhaust, etc.)	•				
Ignition System - Check timing and adjust, if necessary		■		■	■
Crankcase Oil and Oil Filter - Change		•	Refer to Page 1B-23		•
Power Steering Models Only - Check fluid level (A)		•	•		•
Power Package (Entire) - Carefully inspect for leaks (water, coolant, fuel, oil, fluid and exhaust)		•	•		•
Cooling System Hose Clamps - Check tightness; clean and test pressure cap		•		• Note 1	•
Engine Exhaust Bellows Clamps - Check tightness		•		• Note 1	•
Drive Belts (All) - Inspect condition and check tension.		■		•	•
Ignition System - Clean and inspect condition		■		■ Note 1	■
Power Package (Entire) - Check for loose, missing or damaged parts, (especially engine and drive unit mount fasteners and starter, and Power Steering pump mounting fasteners).		•		•	•
Steering System - Lubricate and inspect (Refer to "Stern Drive Service Manual")			• Note 2		•
Battery - Check electrolyte level and specific gravity. Inspect case for damage.			•		•
Electrical System (Entire) - Check loose or dirty connections or damaged wiring (especially battery cables).			• Note 2		•
Fuel Pump Sight Tube (or Glass) - Check for evidence of fuel (indicating a ruptured diaphragm).			•		•
Hoses (All) - Inspect for cracks, swelling, weather checking or other signs of deterioration. Check connections for adequate tightness.				•	•
Engine Exhaust Bellows - Inspect for cracks, swelling, burns or other signs of deterioration.				•	•
Flame Arrestor and Crankcase Ventilation Hose - Clean and Inspect.				•	•

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year
Shift and Throttle Cable and Linkage - Lubricate and inspect. (B)				● Note 2	●
Engine Coupling and Stern Drive Unit Universal Joint Shaft Splines and Cross Bearings - Lubricate (C)				■	■
Engine Alignment - Check				■	■
Driveshaft Extension Models Only - Lubricate (C)				●	●
Fuel Filters - Replace					●
Power Package Exterior Surfaces - Clean and paint. (D) (E)					● Note 3
Seawater Pickup Pump - Disassemble and inspect.					■
Closed Cooling Models Only - Test coolant for alkalinity.					■
Closed Cooling Models Only - Clean heat exchanger seawater section					●
Transom Assembly and Stern Drive Unit	Refer to "Stern Drive Service Manual".				
Cooling System - Flush seawater section (CORROSIVE AREAS ONLY)	After Use Each Day				
Power Package Exterior Surfaces - Spray with rust preventative.	Fresh Water Areas - Every 6 Weeks Salt Water Areas - Every 2-3 Weeks				
Closed Cooling Models Only - Replace coolant (F)	Every 2 Years				
Seawater Pickups - Check for marine growth or debris	Every 30 Days NOTE 4				
Boat Bottom - Clean and paint	As Required				
Carburetor - Adjust	■ As Required				

(A) Use Automatic Transmission Fluid (ATF). Dexron or Dexron II.
(B) Use SAE 30W engine oil.
(C) Use Quicksilver 2-4-C Multi-Lube.
(D) Use Quicksilver Primer and Spray Paint.
(E) Use Quicksilver Corrosion and Rust Preventive Type II.
(F) Use a 50/50 mixture of ethylene glycol anti-freeze that meets GM specification 1825M and pure, soft water. Refer to page 1B-24.

NOTES: (1) In fresh water areas, every 100 hours of operation or 120 days (whichever comes first). In saltwater areas, every 50 hours of operation or 60 days (whichever comes first).
(2) In fresh water areas, every 50 hours of operation or 60 days (whichever comes first). In saltwater areas, every 25 hours of operation or 30 days (whichver comes first).
(3) Requires more frequent attention, if used in extremely salty, polluted or mineral laden waters.
(4) Requires more frequent attention, if used in areas with rapid marine growth.

MCM 470TR/230TR/260TR and MCM 330-475 Turbo Maintenance Schedule

• = To Be Performed by Owner ■ = To Be Performed by an Authorized MerCruiser Dealer

NOTE: Refer to the end of this chart for explanation of lettered references (A, B, etc.) and "NOTES".

⚠WARNING

Always disconnect battery cables from battery BEFORE working around electrical system components to prevent injury to yourself or damage to electrical system should a wire be accidentally shorted.

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year
Engine Crankcase Oil - Check level	•				
Closed Cooling Models Only - Check coolant level	•				
Remote Control and Steering System - Check for proper operation	•				
Power Package (Entire) - Observe for obvious leaks (water, fuel, oil, exhaust, etc.)	•				
Transmission Fluid - Check level (A)	•				
Ignition System - Check timing and adjust, if necessary		■		■	■
Crankcase Oil and Oil Filter - Change		•	Refer to Page 1B-23		•
Power Steering Models Only - Check fluid level (B)		•	•		•
Cooling System Hose Clamps - Check tightness.		•		• Note 1	•
Exhaust Hose Clamps - Check tightness		•		• Note 1	•
Drive Belts (All) - Inspect condition and check tension.		■		•	•
Ignition System - Clean and inspect condition		■		■ Note 1	■
Power Package (Entire) - Carefully inspect for leaks (water, coolant, fuel, oil, fluid and exhaust)		•	•		•
Power Package (Entire) - Check for loose, missing or damaged parts, (especially engine and drive unit mount fasteners and starter, and Power Steering pump mounting fasteners).		•		•	•
Steering System - Lubricate and inspect (Refer to "Stern Drive Service Manual")			• Note 2		•
Battery - Check electrolyte level. Inspect case for damage.			•		•
Electrical System (Entire) - Check loose or dirty connections or damaged wiring (especially battery cables).			• Note 2		•
Fuel Pump Sight Tube (or Glass) - Check for evidence of fuel (indicating a ruptured diaphragm).			•		•
Hoses (All) - Inspect for cracks, swelling, weather checking or other signs of deterioration. Check connections for adequate tightness.				•	•
Engine Exhaust Hoses - Inspect for cracks, swelling, burns or other signs of deterioration.				•	•

Flame Arrestor and Crankcase Ventilation Hose - Clean and Inspect.				●	●
Shift and Throttle Cable and Linkage - Lubricate and inspect. (C)				● Note 2	●
MCM 230/260/330 (B-W) Only - Lubricate Starter Motor (D)				● Note 1	●
Stern Drive Unit Universal Joint Shaft Splines and Cross Bearings - Lubricate (E)				■	■
Drive Shaft and Tailstock Input Bearing, Lubricate (Staggered Installations Only) (E)				●	●
Tailstock Output Bearing, Lubricate (Staggered Installations Only) (E)				●	●
Engine Alignment - Check				■	■
Fuel Filters - Replace					●
Transmission Fluid - Replace and clean strainer. (A)					● Note 3
Power Package Exterior Surfaces - Clean and paint. (F)					● Note 4
Seawater Pickup Pump - Disassemble and inspect.					■
Steering Head and Remote Control - Inspect and lubricate. (E)					■
Closed Cooling Models Only - Test coolant for alkalinity.					■
Closed Cooling Models Only - Clean heat exchanger seawater section					●
Transom Assembly and Stern Drive Unit	Refer to "Stern Drive Service Manual".				
Cooling System - Flush seawater section (CORROSIVE AREAS ONLY)	After Use Each Day				
Power Package Exterior Surfaces - Spray with rust preventative. (G)	Fresh Water Areas - Every 6 Weeks Salt Water Areas - Every 2-3 Weeks				
Closed Cooling Models Only - Replace coolant (H)	Every 2 Years				
Seawater Pickups - Check for marine growth or debris	Every 30 Days NOTE 5				
Boat Bottom - Clean and paint	As Required				
Carburetor - Adjust	■ As Required				

(A) Use Automatic Transmission Fluid (ATF), Type F, Dexron or Dexron II.
(B) Use Automatic Transmission Fluid (ATF), Dexron or Dexron II.
(C) Use SAE 30W engine oil.
(D) Use Lubriplate Extra-Heavy Gear Shield or its equivalent.
(E) Use Quicksilver 2-4-C Multi-Lube.
(F) Use Quicksilver Primer and Spray Paint.
(G) Use Quicksilver Corrosion and Rust Preventive Type II.
(H) Use a 50/50 mixture of ethylene glycol anti-freeze that meets GM specification 1825M and pure, soft water. Refer to page 1B-24.

NOTES: (1) In fresh water areas, every 100 hours of operation or 120 days (whichever comes first). In saltwater areas, every 50 hours of operation or 60 days (whichever comes first).
(2) In fresh water areas, every 50 hours of operation or 60 days (whichever comes first). In saltwater areas, every 25 hours of operation or 30 days (whichever comes first).
(3) Requires more frequent attention, if used for high speed or heavy-duty operation.
(4) Requires more frequent attention, if used in extremely salty, polluted or mineral-laden waters.
(5) Requires more frequent attention, if used in areas with rapid marine growth.

MIE 470-340 MAINTENANCE SCHEDULE

● = To Be Performed by Owner ■ = To Be Performed by an Authorized MerCruiser Dealer

NOTE: Refer to the end of this chart for explanation of lettered references (A, B, etc.) and "NOTES".

⚠WARNING

Always disconnect battery cables from battery BEFORE working around electrical system components to prevent injury to yourself or damage to electrical system should a wire be accidentally shorted.

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year
Closed Cooling Models Only - Check coolant level.	●				
Engine Crankcase Oil - Check level	●				
Power Package (Entire) - Observe for obvious leaks (water, fuel, oil, exhaust, etc.)	●				
Remote Control and Steering System - Check for proper operation	●				
Transmission Fluid - Check level (A)	●				
Cooling System Hose Clamps - Check tightness.		●		● Note 1	●
Drive Belts (All) - Inspect condition and check tension.		■		●	●
Exhaust System - Inspect condition. Check hose clamps for adequate tightness.		●		● Note 1	●
Ignition System - Clean and inspect condition		■		■ Note 1	■
Power Package (Entire) - Check for loose, missing or damaged parts, (especially engine mount fasteners and starter, and alternator mounting fasteners).		●		●	●
Crankcase Oil and Oil Filter - Change		●	Refer to Page 1B-23		●
Engine Alignment - Check		■			■
Ignition System - Check timing and adjust, if necessary.		■			■
Battery - Check electrolyte level and specific gravity. Inspect case for damage.			●		●
Electrical System (Entire) - Check loose or dirty connections or damaged wiring (especially battery cables).			● Note 2		●
Fuel Pump Sight Tube (or Glass) - Check for evidence of fuel.			●		●
Flame Arrestor and Crankcase Ventilation Hoses - Clean and inspect				●	●
Hoses (All) - Inspect for cracks, swelling, weather checking or other signs of deterioration. Check connections for adequate tightness.				●	●

Shift and Throttle Cable and Linkage - Lubricate and inspect. (B)				● Note 1	●
MIE 230/260/340 Only - Lubricate starter motor (C)				● Note 1	●
Fuel Filters - Replace					●
Power Package Exterior Surfaces - Clean and paint. (D)					● Note 3
Seawater Pickup Pump - Disassemble and inspect.					■
Closed Cooling Models Only - Clean seawater section of heat exchanger					● Note 3
Steering Head and Remote Control - Inspect and lubricate. (E)					■
Transmission Fluid - Change. (A)					■ Note 4
Boat Bottom - Clean and paint	As Required				
Carburetor - Adjust	■ As Required				
Closed Cooling Models Only - Clean closed cooling section	As Required				
Closed Cooling Models Only - Change coolant	At Least Once Every 2 Years				
Closed Cooling Models Only - Check coolant for alkalinity	At Least Once Between Change Intervals				
Power Package Exterior Surfaces - Spray with rust preventive. (F)	Fresh Water Areas - Every 6 Weeks Salt Water Areas - Every 2-3 Weeks				
Propeller, Shaft and Strut - Inspect for damage and tighten gland nut (if applicable).	Refer to Boat Manufacturer's Recommendations.				
Sea Strainer (if so eqiupped) - Clean	Refer to Manufacturer's Recommendations.				
Seawater Cooling System - Flush (CORROSIVE AREAS ONLY)	After Use Each Day				
Seawater Pickup - Check for marine growth or debris	Every 30 Days Note 5				
Steering System (Entire) - Check for loose, missing or damaged parts.	Refer to Boat Manufacturer's Recommendations.				

(A) Use Automatic Transmission Fluid (ATF), Type F, Dexron or Dexron II.
(B) Use SAE 30 engine oil.
(C) Use Lubriplate Extra-Heavy Gear Shield or its equivalent.
(D) Use Quicksilver Primer and Spray Paint.
(E) Use Quicksilver 2-4-C Multi-Lube.
(F) Use Quicksilver Corrosion and Rust Preventive Type II.

NOTES: (1) In fresh water areas, every 100 hours of operation or 120 days (whichever comes first). In saltwater areas, every 50 hours of operation or 60 days (whichever comes first).
(2) In fresh water areas, every 50 hours of operation or 60 days (whichever comes first). In saltwater areas, every 25 hours of operation or 30 days (whichever comes first).
(3) Requires more frequent attention, if used in extremely salty, polluted or mineral-laden waters.
(4) Requires more frequent attention, if used for high speed or heavy-duty operation.
(5) Requires more frequent attention, if used in areas with rapid marine growth.

TUNE-UP CHART

MODEL	MCM 120/120R	MCM 140/140R	MCM 165
Horsepower (Kilowatts)	120 (90)	140 (104)	165 (123)
Number of Cylinders	4		6
Displacement	153 CID (2.5 litre)	181 CID (3 litre)	250 CID (4 litre)
Bore/Stroke	3.87"/3.25" (98.3/82.6mm)	4.00"/3.60" (101.7/91.4mm)	3.87"/3.53" (98.3/89.7mm)
Compression Ratio	8.5:1		8.0:1
Compression Pressure	140 PSI (966 kPa)		
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	3900-4300	4200-4600	3900-4300
Oil PSI (At 2000 RPM)	30-60 PSI (207-414 kPa)		
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI (At 1000 RPM)	5 - 6-1/2 PSI (35 - 44 kPa)		
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	305	375	
Firing Order	1-3-4-2		1-5-3-6-2-4
Spark Plug Type	AC-MR43T Autolite-144	Champion - RV8C NKG-BR6FS	
Spark Plug Gap	.035" (.9mm)		
Breaker Point Gap	.022" (.5mm)		.016"-.019" (.4-.45mm)
Dwell	28° - 34°		
Breaker Point Spring Tension	19-23 Oz. (540-650g)		
Timing (At Idle RPM)	8° BTDC	6° BTDC	8° BTDC
Preliminary Idle Mixture	1-1/4 Turns		
Thermostat	143°F (62°C)		

TUNE-UP CHART

MODEL	MCM 470	MCM 470R	MCM 485	MCM 488R
Horsepower (Kilowatts)	170 (127)		185 (131)	188 (140)
Number of Cylinders	4			
Displacement	224 CID (3.7 litre)			
Bore/Stroke	4.36"/3.75" (110.7/95.3mm)			
Compression Ratio	8.8:1			
Compression Pressure	150 PSI (1035 kPa)			
Idle RPM (In Forward Gear)	650-700			
Max. RPM (At W.O.T.)	3800-4200		4400-4800	
Oil PSI (At 2000 RPM)	30-60 PSI (207-414 kPa)			
Min. Oil PSI (At Idle)	4 PSI (28 kPa)			
Fuel Pump PSI (At 1000 RPM)	5 - 6-1/2 PSI (35 - 44 kPa)			
Electrical System	12 Volt Negative (-) Ground			
Min. Battery Cold Cranking Amps	450			
Firing Order	1-3-4-2			
Spark Plug Type	AC-R42TS Autolite-13		Champion - RV9YC NGK-BPR6FS	
Spark Plug Gap	.035" (.9mm)			
Breaker Point Gap	.022" (.5mm)			
Dwell	28° - 34°			
Breaker Point Spring Tension	19-23 Oz. (540-650g)			
Timing (At Idle RPM)	8° BTDC			
Preliminary Idle Mixture	1-1/4 Turns			
Thermostat	160°F (71°C)			

TUNE-UP CHART

MODEL	MCM 898	MCM 228	MCM 260
Horsepower (Kilowatts)	198 (148)	228 (170)	260 (194)
Number of Cylinders	V-8		
Displacement	305 CID (5 litre)		350 CID (5.7 litre)
Bore/Stroke	3.74"/3.48" (95/88.4mm)		4.00"/3.48" (101.6/88.4mm)
Compression Ratio	8.5:1		
Compression Pressure	150 PSI (1035 kPa)	155 PSI (1069 kPa)	150 PSI (1035 kPa)
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	3800-4200	4200-4600	
Oil PSI (At 2000 RPM)	30-55 PSI (207-379 kPa)		
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI (At 1800 RPM)	5-1/4 - 6-1/2 PSI (36 - 44 kPa)		
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	305		350
Firing Order	1-8-4-3-6-5-7-2		
Spark Plug Type	AC-MR43T Autolite-144	Champion - RV8C NGK-BR6FS	
Spark Plug Gap	.035" (.9mm)		
Breaker Point Gap	.016"-.019" (.4-.45mm)		
Dwell	26° - 31°		
Breaker Point Spring Tension	25-30 Oz. (709-850g)		
Timing (At Idle RPM)	8° BTDC		
Preliminary Idle Mixture	1-1/4 Turns	2-3 Turns	
Thermostat	143°F (62°C)		

TUNE-UP CHART

MODEL	MCM 898R	MCM 228R	MCM 260R
Horsepower (Kilowatts)	198 (148)	228 (170)	260 (194)
Number of Cylinders	V-8		
Displacement	305 CID (5 litre)		350 CID (5.7 litre)
Bore/Stroke	3.74"/3.48" (95/88.4mm)		4.00"/3.48" (101.6/88.4mm)
Compression Ratio	8.5:1		
Compression Pressure	150 PSI (1035 kPa)	155 PSI (1069 kPa)	150 PSI (1035 kPa)
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	3800-4200	4200-4600	
Oil PSI (At 2000 RPM)	30-55 PSI (207-379 kPa)		
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI (At 1800 RPM)	5-1/2 - 7 PSI (38 - 48 kPa)		
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	305		350
Firing Order	1-8-4-3-6-5-7-2		
Spark Plug Type	AC-MR43T Autolite-144	Champion - RV8C NGK-BR6FS	
Spark Plug Gap	.035" (.9mm)		
Timing (At Idle RPM)	8° BTDC		
Preliminary Idle Mixture	1-1/4 Turns	2-3 Turns	
Thermostat	143°F (62°C)		

TUNE-UP CHART

MODEL	MCM 330 (B-W)	MCM 330	MCM 370/400
Horsepower (Kilowatts)	330 (246)		370 (262)
Number of Cylinders	V-8		
Displacement	454 CID (7.4 litre)		
Bore/Stroke	4.25"/4.00" (108/101.6mm)		
Compression Ratio	8.5:1	8.2:1	8.6:1
Compression Pressure	150 PSI (1035 kPa)		
Idle RPM (In Forward Gear)	650-700		800-850
Max. RPM (At W.O.T.)	4200-4600		4800-5200
Oil PSI (At 2000 RPM)	30-70 PSI (207-483 kPa)		
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		5 PSI (35 kPa)
Fuel Pump PSI (At 1800 RPM)	5-1/2 - 7 PSI (38 - 48 kPa)	5-1/4 - 6-1/2 PSI (36 - 44 kPa)	
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	450		
Firing Order	1-8-4-3-6-5-7-2		
Spark Plug Type	AC-MR43T Autolite-144	Champion - RV8C NGK-BR6FS	
Spark Plug Gap	.035" (.9mm)		
Breaker Point Gap		.016"-.019" (.4-.45mm)	
Dwell		26° - 31°	
Breaker Point Spring Tension		25-30 Oz. (709-850g)	
Timing (At Idle RPM)	8° BTDC		10° BTDC
Preliminary Idle Mixture	2-3 Turns		
Thermostat	143°F (62°C)		

TUNE-UP CHART

MODEL	MCM 400 CYCLONE	MCM 440 CYCLONE	MCM 460 CYCLONE	MCM 475 TURBO
Horsepower (Kilowatts)	400 (298)	440 (328)	460 (343)	475 354
Number of Cylinders	V-8			
Displacement	454 CID (7.4 litre)		482 CID (7.9 litre)	454 CID (7.4 litre)
Bore/Stroke	4.25"/4.00" (108/102mm)		4.25"/4.25" (108/108mm)	4.25"/4.00" (108/102mm)
Compression Ratio	8.6:1		9.2:1	7:1
Compression Pressure	150 PSI (1035 kPa)		160 PSI (1103 kPa)	130 PSI (896 kPa)
Idle RPM (In Forward Gear)	800-850			
Max. RPM (At W.O.T.)	4800-5200		4800-5400	5200-5400
Oil PSI (At 2000 RPM)	35-70 PSI (241-483 kPa)			
Min. Oil PSI (At Idle)	5 PSI (35 kPa)			
Fuel Pump PSI (At 1800 RPM)	5-1/4 - 6-1/2 PSI (36 - 44 kPa)			
Electrical System	12 Volt Negative (-) Ground			
Min. Battery Cold Cranking Amps	450			
Firing Order	1-8-4-3-6-5-7-2			
Spark Plug Type	AC-MR43T Autolite-144	Champion - RV8C NGK-BR6FS	AC-MR41T	Champion-V4C
Spark Plug Gap	.035" (.9mm)			
Breaker Point Gap	.016" - .019" (.4 - .45mm)			
Dwell	28° - 31°			
Breaker Point Spring Tension	25-30 Oz. (709-850g)			
Timing (At Idle RPM)	10° BTDC		15° BTDC	16° BTDC
Preliminary Idle Mixture	2-3 Turns			
Thermostat	143°F (62°C)			

TUNE-UP CHART

MODEL	MCM 470TR	MCM 230TR	MCM 260TR
Horsepower (Kilowatts)	170 (127)	230 (172)	260 (194)
Number of Cylinders	4	V-8	
Displacement	224 CID (3.7 litre)	305 CID (5 litre)	350 CID (5.7 litre)
Bore/Stroke	4.36"/3.75" (110.7/95.3mm)	3.74"/3.48" (95/88.4mm)	4.00"/3.48" (101.6/88.4mm)
Compression Ratio	8.8:1	8.5:1	
Compression Pressure	150 PSI (1035 kPa)	155 PSI (1069 kPa)	150 PSI (1035 kPa)
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	3800-4200	4000-4400	
Oil PSI (At 2000 RPM)	30-60 PSI (207-414 kPa)	30-55 PSI (207-379 kPa)	
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI	5 - 6-1/2 PSI (35 - 44 kPa)	5-1/2 - 7 PSI (38 - 48 kPa)	
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	450	305	350
Firing Order	1-3-4-2	1-8-4-3-6-5-7-2	
Spark Plug Type	Same as MIE 470	AC-MR43T Autolite-144	Champion - RV8C NGK-BR6FS
Spark Plug Gap	.035" (.9mm)		
Breaker Point Gap	.022" (.5mm)		
Dwell	28° - 34°		
Breaker Point Spring Tension	19-23 Oz. (540-650g)		
Timing (At Idle RPM)	8° BTDC		
Preliminary Idle Mixture	1-1/4 Turns	2-3 Turns	
Thermostat	160°F (71°C)	143°F (62°C)	

TUNE-UP CHART

MODEL	MIE 470
Horsepower (Kilowatts)	170 (127)
Number of Cylinders	4
Displacement	224 CID (3.7 litre)
Bore/Stroke	4.36"/3.75" (110.7/95.3mm)
Compression Ratio	8.8:1
Compression Pressure	150 PSI (1035 kPa)
Idle RPM (In Forward Gear)	650-700
Max. RPM (At W.O.T.)	3800-4200
Oil PSI (At 2000 RPM)	30-60 PSI (207-414 kPa)
Min. Oil PSI (At Idle)	4 PSI (28 kPa)
Fuel Pump PSI (At 1000 RPM)	5 - 6-1/2 PSI (35 - 44 kPa)
Electrical System	12 Volt Negative (-) Ground
Min. Battery Cold Cranking Amps	450
Firing Order	1-3-4-2 L.H. or R.H. Rotation
Spark Plug Type	AC-R42TS Champion - RV9YC Autolite-13 NGK-BPR6FS
Spark Plug Gap	.035" (.9mm)
Breaker Point Gap	.022" (.5mm)
Dwell	28° - 34°
Breaker Point Spring Tension	19-23 Oz. (540-650g)
Timing (At Idle RPM)	8° BTDC
Preliminary Idle Mixture	1-1/4 Turns
Thermostat	160°F (71°C)

TUNE-UP CHART

MODEL	MIE 228	MIE 255	MIE 330
Horsepower (Kilowatts)	228 (170)	255 (190)	330 (246)
Number of Cylinders	V-8		
Displacement	305 CID (5 litre)	350 CID (5.7 litre)	454 CID (7.4 litre)
Bore/Stroke	3.74"/3.48" (95/88.4mm)	4.00"/3.48" (101.6/88.4mm)	4.25"/4.00" (108/101.6mm)
Compression Ratio	8.5:1		8.2:1
Compression Pressure	155 PSI (1069 kPa)	150 PSI (1035 kPa)	
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	4000-4400	3800-4200	
Oil PSI (At 2000 RPM)	30-55 PSI (207-379 kPa)		30-70 PSI (207-483 kPa)
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI (At 1800 RPM)	5-1/4 - 6-1/2 PSI (36 - 44 kPa)		
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	305	350	450
Firing Order	L.H. Rot. 1-8-4-3-6-5-7-2		R.H. Rot. 1-2-7-5-6-3-4-8
Spark Plug Type	AC-MR43T Autolite-144	Champion - RV8C NGK-BR6FS	
Spark Plug Gap	.035" (.9mm)		
Breaker Point Gap	.016"-.019" (.4-.45mm)		
Dwell	26° - 31°		
Breaker Point Spring Tension	25-30 Oz. (709-850g)		
Timing (At Idle RPM)	8° BTDC		
Preliminary Idle Mixture	2-3 Turns		
Thermostat	143°F (62°C)		

TUNE-UP CHART

MODEL	MIE 230	MIE 260	MIE 340
Horsepower (Kilowatts)	230 (172)	260 (194)	340 (254)
Number of Cylinders	V-8		
Displacement	305 CID (5 litre)	350 CID (5.7 litre)	454 CID (7.4 litre)
Bore/Stroke	3.74"/3.48" (95/88.4mm)	4.00"/3.48" (101.6/88.4mm)	4.25"/4.00" (108/101.6mm)
Compression Ratio	8.5:1		
Compression Pressure	155 PSI (1069 kPa)	150 PSI (1035 kPa)	
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	4000-4400		
Oil PSI (At 2000 RPM)	30-55 PSI (207-379 kPa)		30-70 PSI (207-483 kPa)
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI (At 1800 RPM)	5-1/2 - 7 PSI (38 - 48 kPa)		
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	305	350	450
Firing Order	L.H. Rot. 1-8-4-3-6-5-7-2		R.H. Rot. 1-2-7-5-6-3-4-8
Spark Plug Type	AC-MR43T Autolite-144	Champion - RV8C NGK-BR6FS	
Spark Plug Gap	.035" (.9mm)		
Timing (At Idle RPM)	8° BTDC		
Preliminary Idle Mixture	2-3 Turns		
Thermostat	143°F (62°C)		

CAPACITY CHART

NOTICE
All Capacities are approximate

MODEL	MCM 120/120R	MCM 140/140R	MCM 165
Crankcase (with Filter)	4 Qts. (3.8 litres)		5 Qts. (4.7 litres)
Standard Cooling System	9 Qts. (8.5 litres)		11 Qts. (10.4 litres)
Closed Cooling System	9 Qts. (8.5 litres)		11 Qts. (10.4 litres)
Stern Drive Unit	32 Fl. Oz. (.95 litres)		

MODEL	MCM 470	MCM 470R	MCM 485	MCM 488R
Crankcase (with Filter)	5-1/2 Qts. (5.2 litres)		5-3/4 Qts. (5.4 litres)	6-1/2 Qts. (6.1 litres)
Closed Cooling System	10-1/2 Qts. (9.9 litres)	11 Qts. (10.4 litres)	10-1/2 Qts. (9.9 litres)	11 Qts. (10.4 litres)
Stern Drive Unit	32 Fl. Oz. (.95 litres)			

MODEL	MCM 898/898R	MCM 228/228R	MCM 260/260R
Crankcase (with Filter)	5 Qts. (4.7 litres)	5-1/2 Qts. (5.2 litres)	
Standard Cooling System	15 Qts. (14.1 litres)		
Closed Cooling System	20 Qts. (19 litres)		
Stern Drive Unit	32 Fl. Oz. (.95 litres)		

CAPACITY CHART

NOTICE
All Capacities are approximate

MODEL	MCM 330	MCM 330 (B-W)	MCM 370/400
Crankcase (with Filter)	6 Qts. (5.6 litres)	7 Qts. (6.6 litres)	6 Qts. (5.6 litres)
Standard Cooling System	20 Qts. (19 litres)		
Closed Cooling System		28 Qts. (26.5 litres)	
Transmission	2 Qts. (1.8 litres)		
Stern Drive Unit (TR)	4 Qts. (3.8 litres)		
Stern Drive Unit (TRS)	3 Qts. (2.8 litres)		

MODEL	MCM 400/440 CYCLONE	MCM 460 CYCLONE	MCM 475 TURBO
Crankcase (with Filter)	7 Qts. (6.6 litres)	10 Qts. (9.4 litres)	8 Qts. (7.5 litres)
Standard Cooling System	20 Qts. (19 litres)		
Transmission	2 Qts. (1.8 litres)		
Stern Drive Unit (TRS)	3 Qts. (2.8 litres)		

CAPACITY CHART

NOTICE
All Capacities are approximate

MODEL	MCM 470TR	MCM 230TR	MCM 260TR
Crankcase (with Filter)	5-1/2 Qts. (5.2 litres)	6 Qts. (5.6 litres)	
Standard Cooling System		15 Qts. (14.1 litres)	
Closed Cooling System	10-1/2 Qts. (9.9 litres)	20 Qts. (19 litres)	
Transmission	2 Qts. (1.8 litres)		
Stern Drive Unit (TR)	4 Qts. (3.8 litres)		

CAPACITY CHART

NOTICE
All Capacities are approximate

MODEL	MIE 470	MIE 228/255	MIE 330
Crankcase (with Filter)	5-1/2 Qts. (5.2 litres)	6 Qts. (5.6 litres)	7 Qts. (6.6 litres)
Standard Cooling System		15 Qts. (14.1 litres)	20 Qts. (19 litres)
Closed Cooling System	10-1/2 Qts. (9.9 litres)	20 Qts. (19 litres)	28 Qts. (26.5 litres)
Transmission 1:1	2 Qts. (1.8 litres)		
Transmission 1.5:1-3.0:1	3 Qts. (2.8 litres)		
Transmission V-Drive	4 Qts. (3.8 litres)		

MODEL	MIE 230	MIE 260	MIE 340
Crankcase (with Filter)	6 Qts. (5.6 litres)		7 Qts. (6.6 litres)
Standard Cooling System	15 Qts. (14.1 litres)		20 Qts. (19 litres)
Closed Cooling System	20 Qts. (19 litres)		28 Qts. (26.5 litres)
Transmission 1:1	2 Qts. (1.8 litres)		
Transmission 1.5:1-3.0:1	3 Qts. (2.8 litres)		
Transmission V-Drive	4-1/2 Qts. (4.2 litres)		

FUEL, OIL, FLUID and COOLANT SPECIFICATIONS

FUEL

⚠CAUTION

Use of improper gasoline can damage the engine seriously. Engine damage, that results from use of improper gasoline, is considered misuse of the engine and is not covered under MerCruiser Warranty.

The use of any good grade regular leaded, premium, low-lead or lead-free automotive gasolines with a minimum posted octane rating of 86 (research octane number 90), are satisfactory for use in MerCruiser marine engines. [Hi-Performance models: Minimum posted octane rating of 88 (research octane number 93). If 88 octane is not available, a gasoline with an average octane rating as low as 86 (research octane number 90) may be used: however, ignition timing must be retarded 4° to prevent harmful detonation.]

However, gasolines containing alcohol, either methyl alcohol (methanol) or ethyl alcohol (ethanol) may cause increased:

- Corrosion of metal parts
- Deterioration of elastomer and plastic parts
- Fuel permeation through flexible fuel lines
- Wear and damage of internal engine parts
- Starting and operating difficulties.

Some of these adverse effects are due to the tendency of gasolines containing alcohol to absorb moisture from the air, resulting in a phase of water and alcohol separating from the gasoline in the fuel tank.

The adverse effects of alcohol are more severe with methyl alcohol (methanol) and are worse with increasing alcohol content.

⚠WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of the fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of the entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic, metal or fiberglass, fuel lines, fittings, fuel filters, fuel pumps and carburetors should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration necessitates replacement before further engine operation.

Because of the possible adverse effects of alcohol in gasoline, it is recommended that only alcohol free gasoline be used where possible. If only alcohol containing fuel is available, or if the presence of alcohol is unknown, then increased inspection frequency for leaks and abnormalities is required.

No Lead Gasoline/Alcohol Blends

LEAD

Recent regulations by the U.S. Environmental Protection Agency (EPA) and the Canadian government have required the removal of lead (anti-knock compound) from all gasoline by 1988 due to the lead emission in exhaust being a health hazard.

In order to maintain octane ratings, many gasoline manufacturers are adding ethyl alcohol (ethanol) or methyl alcohol (methanol) to the gasoline to replace the lead.

Since 1975, Mercury Marine has recommended operation of MerCruiser marine engines with any good grade regular leaded, premium, low-lead or no-lead gasolines with a minimum average octane rating of 88. Prior to that time, recommendations were to use one tank of leaded gasoline for every four tanks of no-lead gasoline. Mercury Marine has recently amended its fuel recommendations for MerCruiser engines.

NO LEAD GASOLINE WITH A MINIMUM POSTED AVERAGE OCTANE RATING OF 86, MAY BE USED IN MERCRUISER MARINE ENGINES AS STATED ABOVE. (HI-PERFORMANCE MODELS ARE EXCEPTIONS.)

GASOLINE/ALCOHOL BLENDS

Many new motor vehicle owner manuals are warning about the potential damage from using gasoline containing alcohol, especially **METHANOL.** They cite possible fuel system damage and performance problems. These are just two of the hazards that may be caused by alcohol. These same problems as well as the additional safety risk of fire and explosion from fuel system leaks apply to marine inboard engines. **METHANOL** is more severe in its bad effects than is **ETHANOL.** Alcohol is also more severe in older engines since newer engines have materials which are more resistant to alcohol.

EFFECTS OF GASOLINE/ALCOHOL BLENDS ON MARINE ENGINES

Corrosion of metals may result from use of alcohol-gasoline blends. Portable or permanently installed fuel tanks of metal or fiberglass, fuel filters, fuel lines and float bowls may be affected by alcohol blended fuels. Many fiberglass fuel tanks are slowly dissolved by alcohol, leading immediately to filter and carburetor plugging and eventually to fuel tank failure.

Alcohol containing fuels will absorb moisture from the air. At first, this moisture will remain in solution, but once the water content of the fuel has built up to about one-half of one percent, it will separate out, (phase separation) bringing the alcohol with it. This alcohol-water mixture settles to the bottom of the fuel tank and if this mixture gets into the engine, engines can be seriously damaged internally, as it may wash the protective film of oil off the bore of any cylinder that it enters. Before the engine can be restarted, it is necessary to remove the separated alcohol and water layer, flush out the fuel system with clean fuel and remove and dry the spark plugs.

BOAT/MOTOR STORAGE

When operating a MerCruiser on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided.

Long periods of storage, common to boats, create unique problems. In cars, gasoline/alcohol blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

WINTER STORAGE

If boat is to be placed in winter storage, carburetors must be run dry at idle RPM. Permanent fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Portable fuel tanks should be emptied completely.

It is also recommended to coat the internal engine parts with Quicksilver Storage Seal. Follow the directions on the container. This coating will reduce possibilities of internal parts becoming rusted from moisture accumulation during storage.

WARRANTY

Performance problems, fuel system or other damage resulting from the use of gasoline-alcohol blended fuels is not the responsibility of Mercury Marine and will not be covered under our warranty.

CONTINUING EVALUATIONS

The effects of gasoline blended with ETHANOL and METHANOL are still being evaluated by the United States Coast Guard, the National Marine Manufacturers Association (NMMA), Mercury Marine and other engine and boat manufacturers.

We have recommended pump posting of alcohol content of gasoline. Further we recommend using gasoline known not to contain any METHANOL or ETHANOL when possible.

TEST FOR ALCOHOL CONTENT IN GASOLINE

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. (Outboard motors only: It should be conducted on the fuel **before the addition of oil** as the oil may obscure any change in separation level.) Use any small transparent bottle or tube that can be capped and is or can be provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

PROCEDURE

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, and then cap the container. The proportions of fuel to water are not critical, but there should be 2-3 times as much fuel as water.
3. Shake container vigorously and allow it to sit upright for up to about 3-5 minutes. **If the volume of water appears to have increased, alcohol is present.** If you are not sure, there is not enough to be of concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

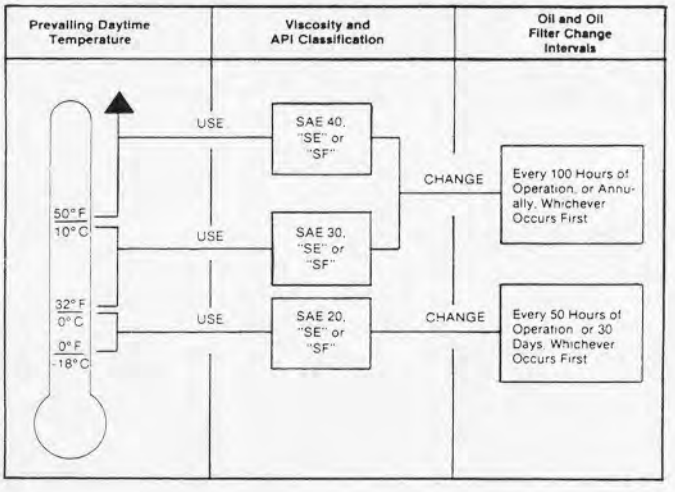
CRANKCASE OIL

After the 20-hour break-in oil has been drained, select a crankcase oil based on the prevailing daytime temperature in the area in which the boat is operated.

The chart below is the guide to crankcase oil selection and recommended change intervals. Oil filter should always be changed with oil.

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle Marine Engine Oil. If not available, however, a good grade detergent automotive oil of correct viscosity, that has an API classification of "SE" or "SF", may be used.

IMPORTANT: The use of multi-viscosity oils specifically is not recommended for use in MerCruiser Engines. In those areas, however, where the recommended straight weight oil is not available, a multi-viscosity 20W-40 ("SE" or "SF") or, as a second but less preferable choice, 20W-50 ("SE" or "SF") may be used. The use of multi-viscosity oils (other than 20W-40 or 20W-50), oils which contain "solid" additives, non-detergent oils, or low quality oils specifically are not recommended.



POWER STEERING

IMPORTANT: Use only automatic transmission fluid (ATF), Dexron® or Dexron II in Power Steering System.

TRANSMISSION

MERCURY MARINE TRANSMISSION

Dexron® II, Type F or any other automatic transmission fluids (ATF) currently used in passenger cars are suitable for use in transmission.

VELVET DRIVE® (BORG-WARNER)

Dexron® II, Type F, or other hydraulic transmission Fluids which meet the Detroit Diesel Allison Type C3 specifications are recommended for use in all Velvet Drive® marine transmissions.

COOLANT

⚠CAUTION

Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

It is recommended that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Any brand of permanent type anti-freeze solution that is made for aluminum component engines can be used in aluminum MerCruiser engines. DO NOT MIX the new anti-freeze solution with the old solution or it will cause small particles to form in the coolant. These small particles can settle in the heat exchanger and restrict coolant flow. Drain and flush the old anti-freeze solution from the closed cooling system. All other MerCruiser engine can use any type of permanent anti-freeze or any brand anti-freeze solution that meets G.M. specification 1825M.

MAINTAINING CRANKCASE OIL LEVEL

OVER-FILLING ENGINE CRANKCASE

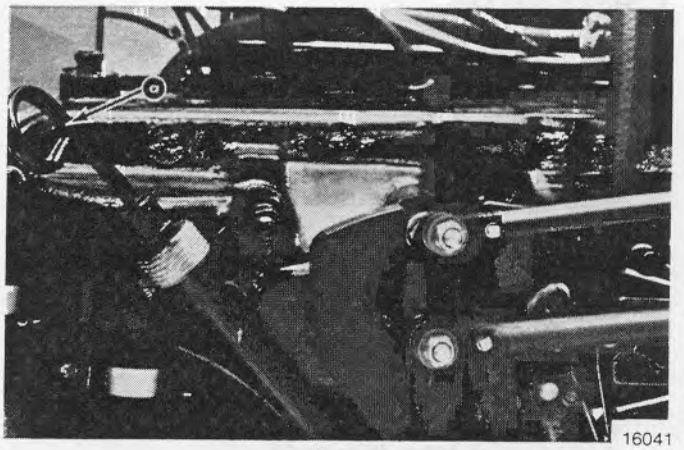
Over full crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter", on MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil caused the hydraulic valve lifters to "bleed down". This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the "add mark" and the "full mark" on the dipstick. To ensure that you are not getting a "false reading", make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, OR
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

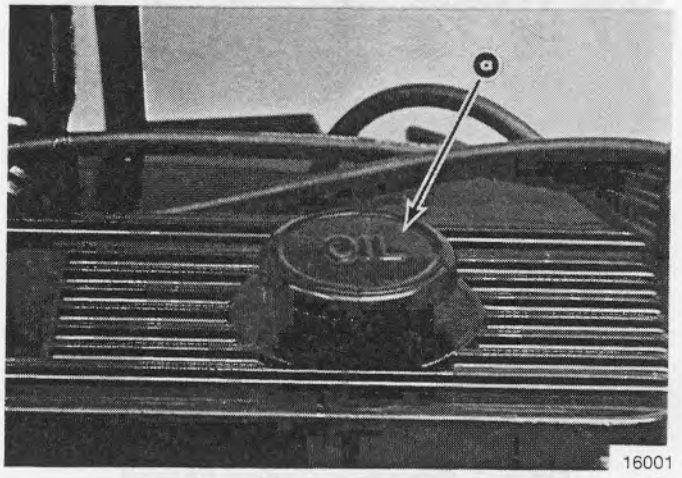
CHECKING LEVEL/FILLING

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick (Figure 1) - Wipe clean and reinstall. Push dipstick all-the-way into dipstick tube.
4. Remove dipstick and note the oil level.
5. Oil level must be between the "FULL" and "ADD" marks. (Figure 1)
6. If oil level is below "ADD" mark, proceed to step 7 and 8.
7. Remove oil filler cap from valve rocker arm cover. (Figure 2)
8. Add required amount of oil to bring level up to, but not over, the "FULL" mark on dipstick.



a - Dipstick
b - Oil Level

Figure 1. Oil Level (Typical Engine)



a - Fill Cap

Figure 2. Adding Oil (Typical Engine)

CHANGING OIL and FILTER

CHANGING OIL

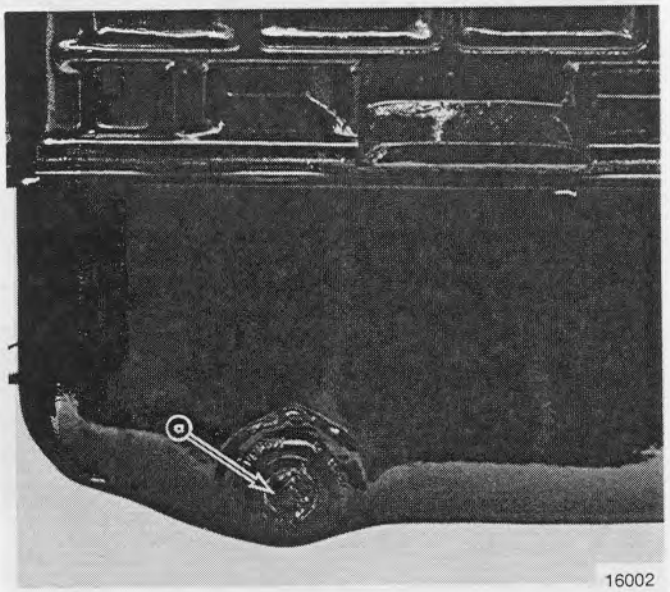
1. Start engine and run until it reaches normal operating temperatures.

   IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan, and allow oil to drain into suitable container, or pan. (Figure 1)

   IMPORTANT: If drain plug is not accessible because of boat construction, oil may be removed thru dipstick tube. (Figure 2)

4. After oil has drained completely, reinstall drain plug and tighten securely.

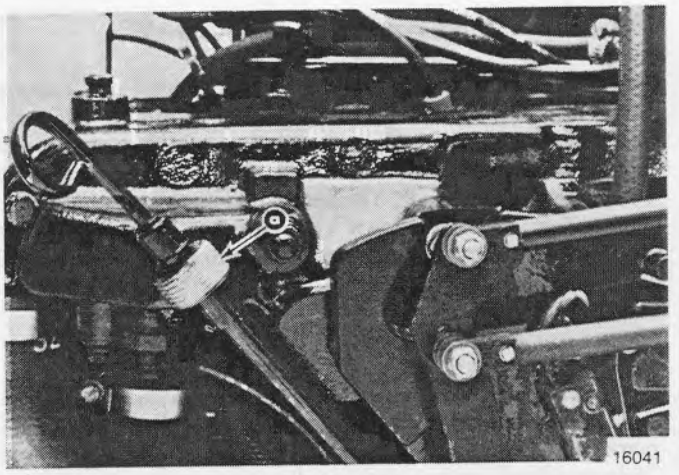


a - Drain Plug

Figure 1. Drain Plug (Typical Engine)

5. Fill crankcase with specified oil as outlined in "Maintaining Crankcase Oil Level" in this section.

   IMPORTANT: ALWAYS use dipstick to determine exact quantity of oil required. DO NOT overfill.

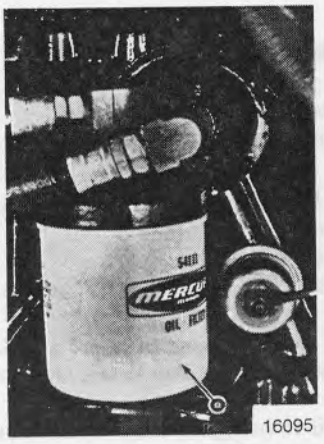


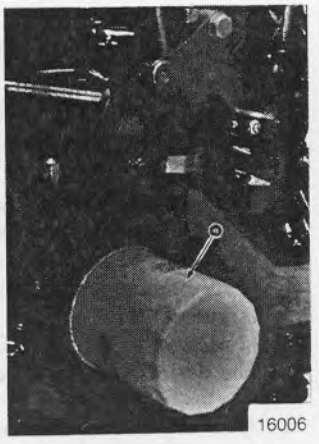
a - Dipstick Tube

Figure 2. Dipstick Tube (Typical Engine)

CHANGING FILTER

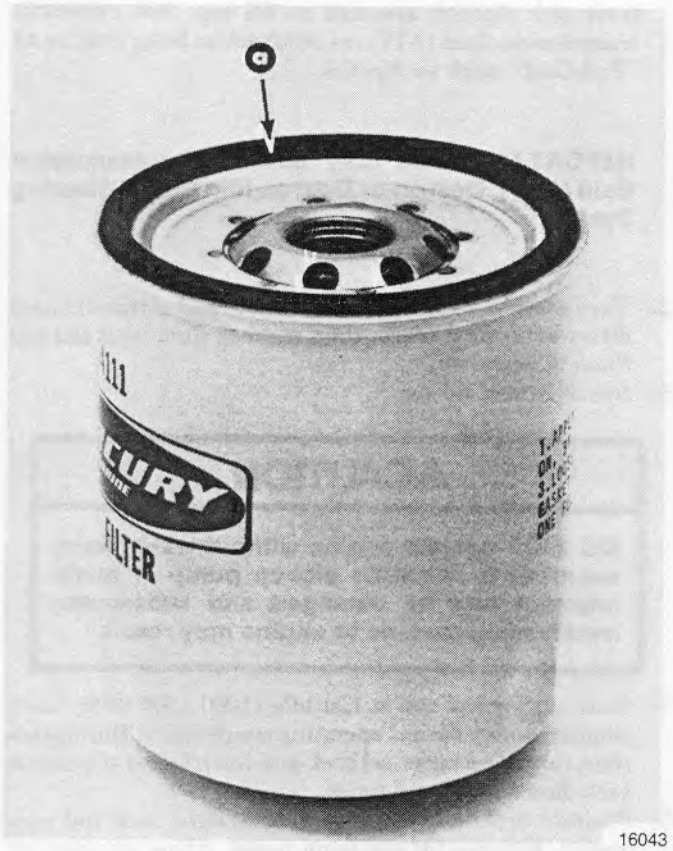
1. Remove and discard oil filter and its sealing ring. (Figure 3)
2. Coat sealing ring (Figure 4) on new filter with engine oil, and install new filter. Tighten filter SECURELY, BUT DO NOT OVER-TIGHTEN.





a - Oil Filter

Figure 3. Changing Oil Filter (Typical Engines)



a - Sealing Ring - Coat with Engine Oil

Figure 4. Sealing Ring (Typical Filter)

MAINTAINING POWER STEERING FLUID LEVEL

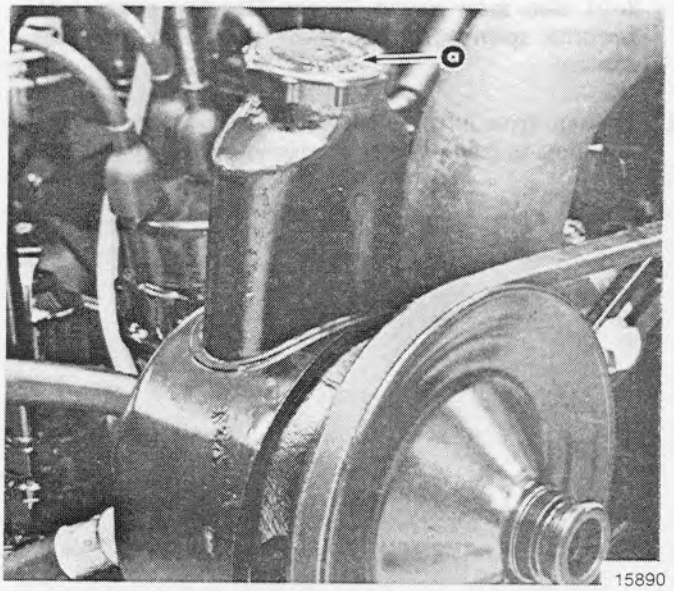
IMPORTANT: Use only automatic transmission fluid (ATF), Dexron or Dexron II in Power Steering System.

With Engine Cold

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level. (Figure 1)
3. Level should be between "FULL COLD" mark and bottom of dipstick. (Figure 2)
4. If fluid level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of automatic transmission fluid (ATF), thru fill cap opening, to bring level up to "FULL COLD" mark on dipstick. DO NOT OVERFILL.

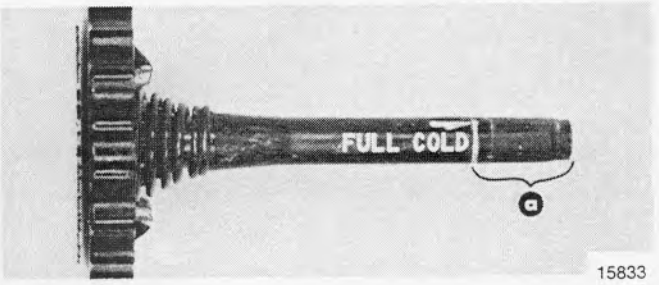
With Engine Warm from Operation

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level. (Figure 1)
3. Level should be between "FULL HOT" mark and "ADD" mark on dipstick. (Figure 2)
4. If level is low (below "ADD" mark), but fluid is still visible in pump reservoir, add required amount of automatic transmission fluid (ATF), thru fill cap opening, to bring level up to "FULL HOT" mark on dipstick. DO NOT OVERFILL.



a - Fill Cap/Dipstick

Figure 1. Checking Fluid Level



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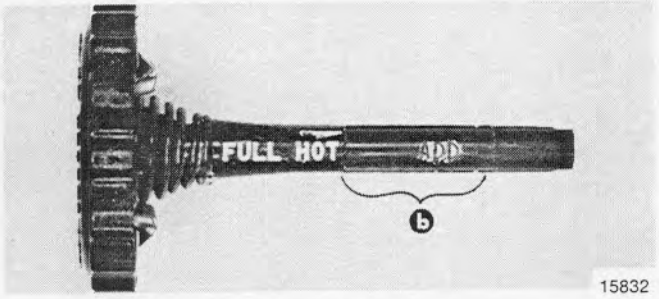

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a - Engine Cold
b - Engine Warm

Figure 2. Fill Cap/Dipstick

FILLING and BLEEDING SYSTEM

IMPORTANT: Power Steering system MUST BE filled exactly as explained, following to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering system to become spongy, which may result in poor boat control.

1. Position drive unit so that it is straight back. Remove shipping cap from Power Steering pump and check fluid level with dipstick attached to fill cap. Add automatic transmission fluid (ATF), as required, to bring level up to "Full-Cold" mark on dipstick.

IMPORTANT: Use only automatic transmission fluid (ATF), Dexron or Dexron II in Power Steering System.

2. Turn steering wheel back-and-forth to end of travel in each direction several times; then recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back-and-forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse, then check fluid level and add fluid, as required, to bring level up to "Full-Hot" mark on dipstick. DO NOT OVERFILL. Reinstall fill cap securely.

IMPORTANT: Drive unit MUST BE positioned straight back and Power Steering fluid MUST BE hot to accurately check fluid level.

6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

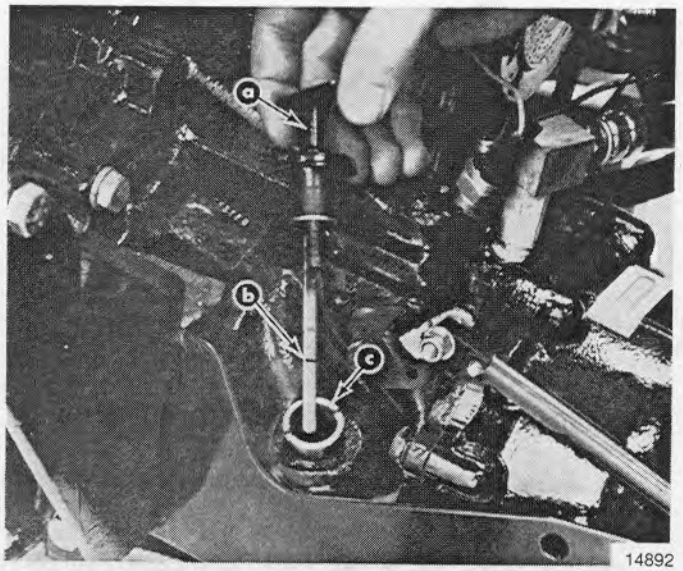
MAINTAINING TRANSMISSION FLUID LEVEL

BORG-WARNER TRANSMISSION

IMPORTANT: Use only recommended fluid.

Transmission fluid should be checked when starting engine each day, as follows:

1. Remove dipstick. Check to ensure that fluid is indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add automatic transmission fluid (ATF) until level comes up to full mark on dipstick.



a - Dipstick
b - Full Mark
c - Dipstick Tube

Figure 1. Checking Transmission Fluid Level

IMPORTANT: To accurately check fluid level, engine MUST BE run at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

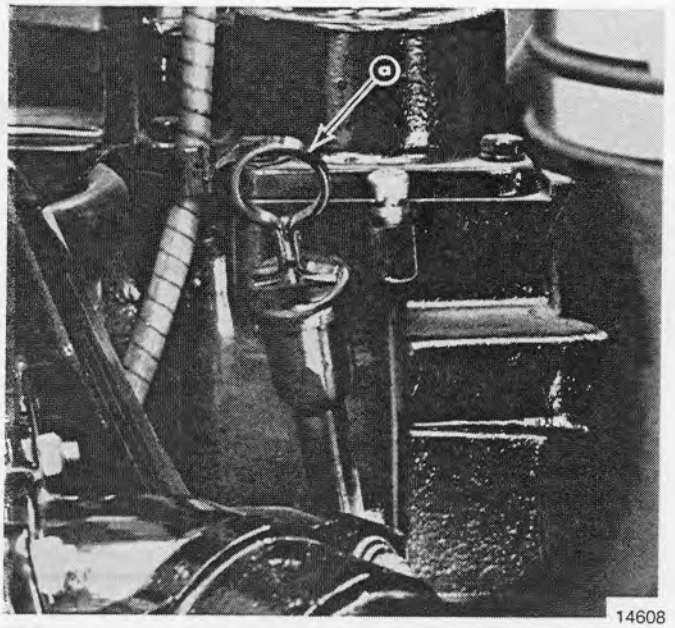
IMPORTANT: Be sure to push dipstick all-the-way down into dipstick tube when checking fluid level.

3. Stop engine and QUICKLY check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick.
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

MERCURY MARINE TRANSMISSION

IMPORTANT: Use only recommended fluid.

Transmission fluid level should be checked before starting engine each day. Check level with dipstick, located on starboard (right) side of transmission. (Figure 2) Fluid level should be maintained between "Full" and "Add" marks on dipstick. If low, add recommended fluid thru dipstick tube to bring level up to "Full" mark.



a - Dipstick

Figure 2. Transmission Dipstick Location

MAINTAINING COOLANT LEVEL

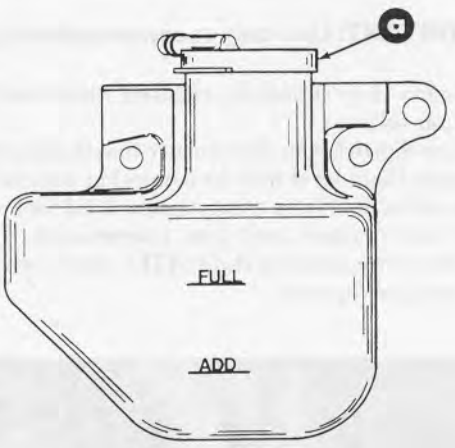
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Coolant level in heat exchanger should be within 1" (25mm) from bottom of filler neck.

   IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on fill neck.

2. Coolant level should be between the "Add" and "Full" mark on coolant recovery reservoir with engine at normal operating temperature. (Figure 1)



193-HR

a - Fill Cap

Figure 1. Coolant Recovery Bottle

FLUSHING COOLING SYSTEM

If engine is operated in salty, polluted or mineral-laden waters, cooling system should be flushed periodically (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Cooling system also should be thoroughly flushed prior to storage.

⚠WARNING

When flushing cooling system with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby.

IMPORTANT: DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

IMPORTANT: If cooling system is to be flushed with boat in the water, water inlet valve (if so equipped) must be closed, or water inlet hose MUST BE disconnected and plugged to prevent water from flowing into boat.

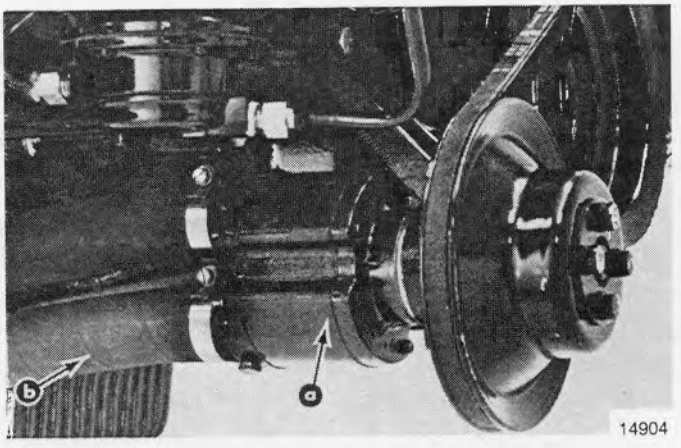
⚠CAUTION

Watch temperature gauge at dash to ensure that engine does not overheat.

BELT DRIVEN SEAWATER PICKUP PUMP

1. Loosen hose clamp and remove water inlet hose at location shown in Figure 1 or 2.

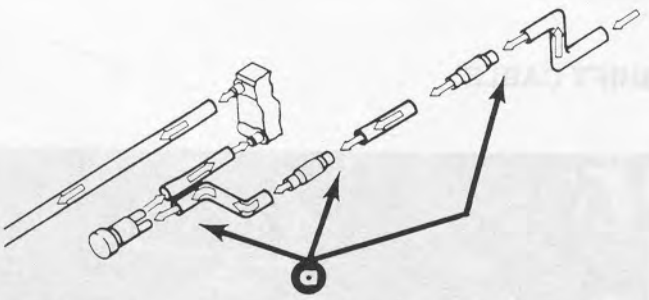
IMPORTANT: MCM 898/898R/228/228R/260/260R Engines: if engine has a Closed Cooling system or is a Drive Shaft Extension model refer to Figure 3 also, if cooling system is going to be flushed with boat out of the water. Two independent water connects are required on these models.



14904

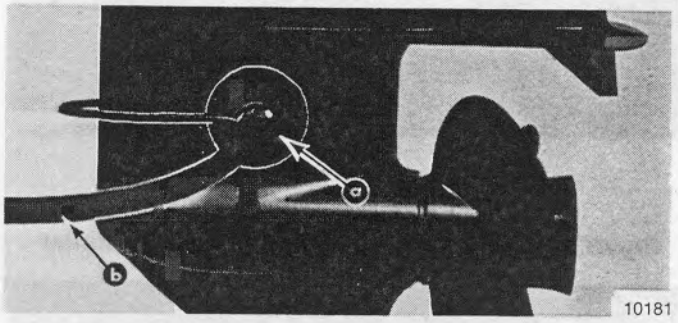
a - Seawater Pickup Pump
b - Seawater Inlet Hose

Figure 1. All V-8 Engines Except MCM 370/400 and Hi-Performance 454 CID Engines.



a - Disconnect Hose - Cooling Water Must Flow Thru Cooler(s) if Engine is so Equipped

Figure 2. MCM 370/400 and Hi-Performance Engines

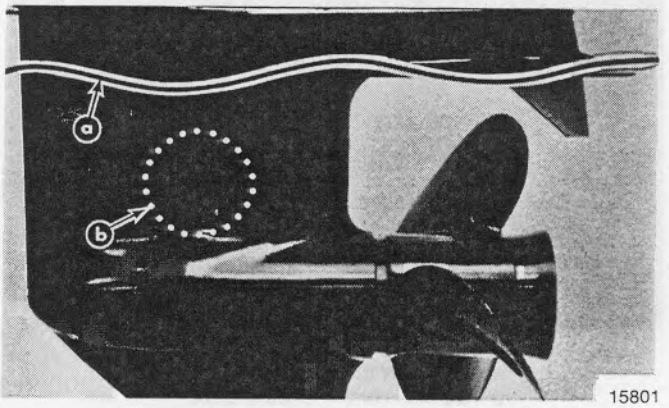


a - Flush Device
b - Garden Hose

Figure 3. Flush Device on Stern Drive

3. Place the remote control lever in neutral position and start the engine. Operate engine at idle speed in neutral gear for 10 minutes or until discharge water is clear, then stop engine.
4. Shut off water tap. Remove flushing connector from pump inlet and reconnect water inlet hose. Be sure to tighten clamp securely.

1. Install Flush Device and connect garden hose between it and water tap. (Figure 3)
2. Salt water areas and boat in the water:
   a. Raise stern drive unit to full trailer position.
   b. Install flush device over water intake holes. (Figure 4)
   c. Lower stern drive unit to full down position.

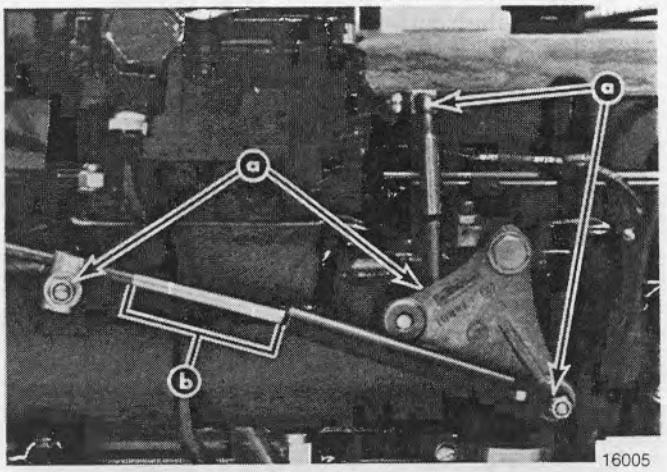


a - Minimum Water Level
b - Water Intake Holes

Figure 4. Minimum Water Level

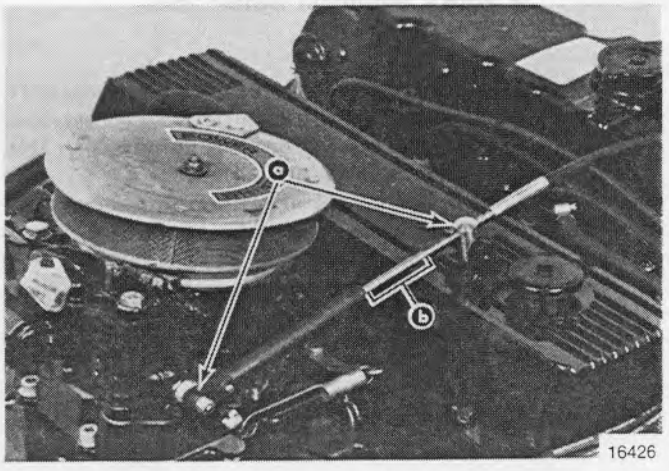
3. Partially open water tap (approx. ½ maximum capacity) and allow cooling system to fill completely. Cooling system is full when water is discharged thru the propeller. DO NOT use full water tap pressure.
4. Place remote control in neutral position and start engine. Watch temperature gauge on instrument panel to ensure that engine does not overheat.
5. Stop engine, turn off water tap and remove Flush Device.

THROTTLE CABLE



a - SAE 30W Engine Oil
b - Quicksilver 2-4-C Multi-Lube

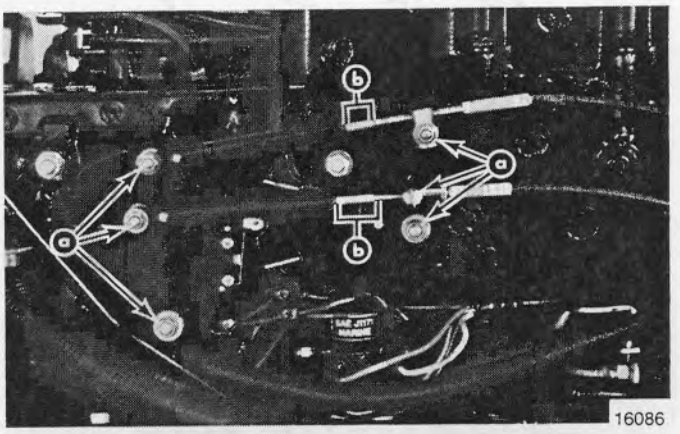
Figure 1. Typical 2 Barrel Carburetor



a - SAE 30W Engine Oil
b - Quicksilver 2-4-C Multi-Lube

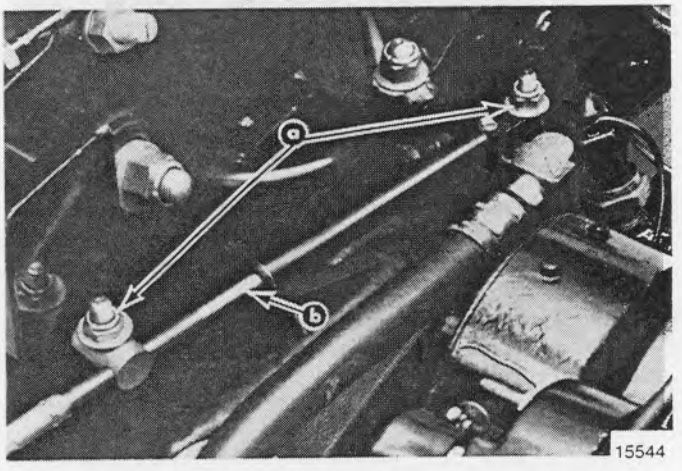
Figure 2. Typical 4 Barrel Carburetor

SHIFT CABLE



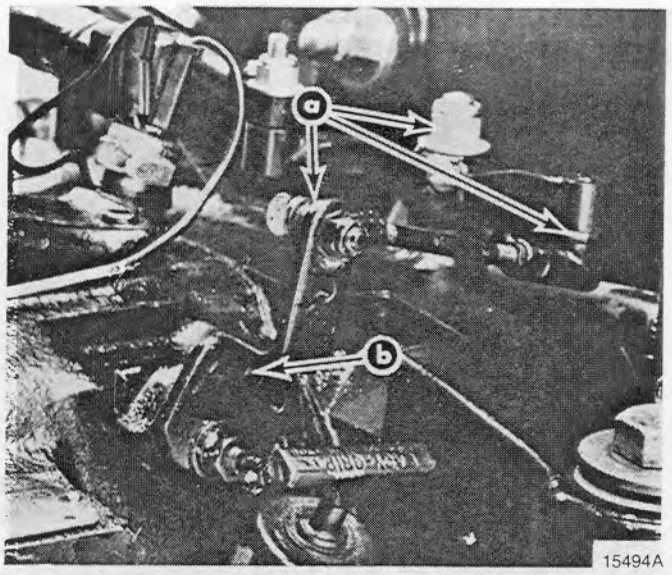
a - SAE 30W Engine Oil
b - Quicksilver 2-4-C Multi-Lube

Figure 3. Typical MCM 120-260 Stern Drive Model



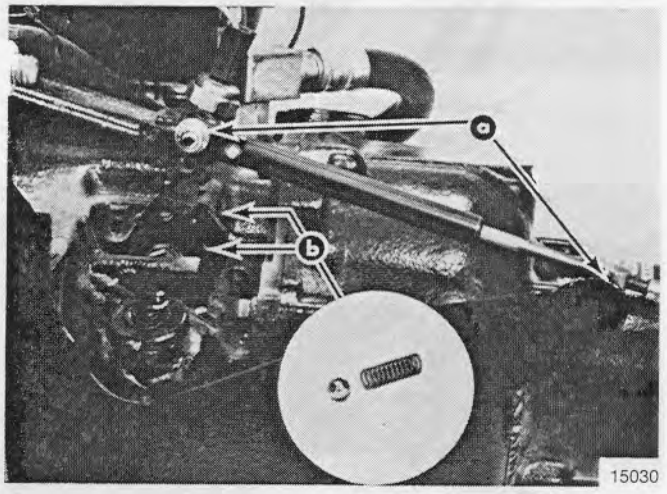
a - SAE 30W Engine Oil
b - Quicksilver 2-4-C Multi-Lube

Figure 4. Typical MCM 330 - 475 Turbo Stern Drive Model



a - SAE 30W Engine Oil
b - Quicksilver 2-4-C Multi-Lube

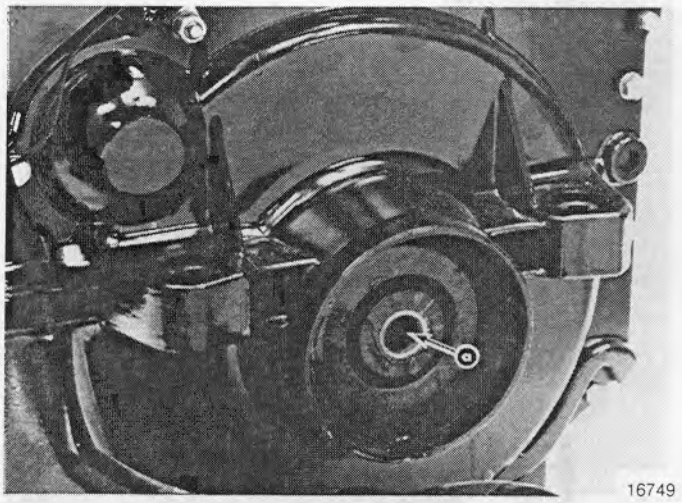
Figure 5. Typical MCM 330 - 475 Turbo Stern Drive Model



a - SAE 30W Engine Oil
b - Quicksilver 2-4-C Multi-Lube

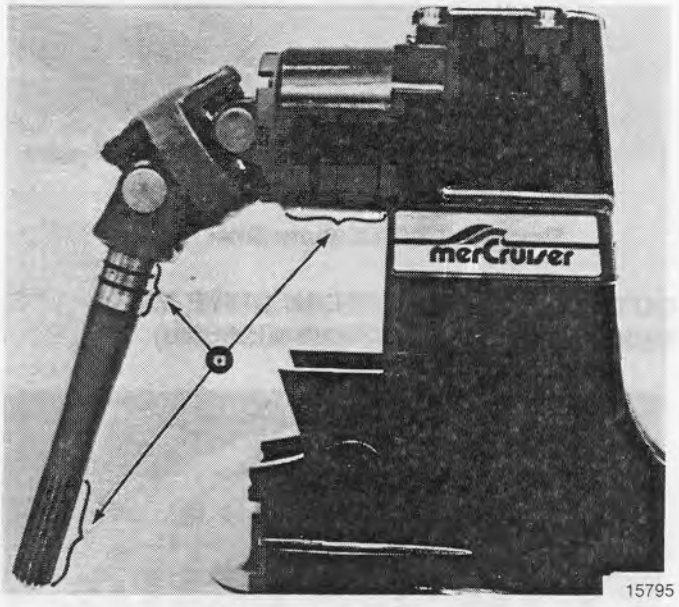
Figure 6. Typical MIE 470 - 340 Inboard Model

ENGINE COUPLING/"U"-JOINT SPLINES (MCM 120-260)



a - Quicksilver 2-4-C Multi-Lube

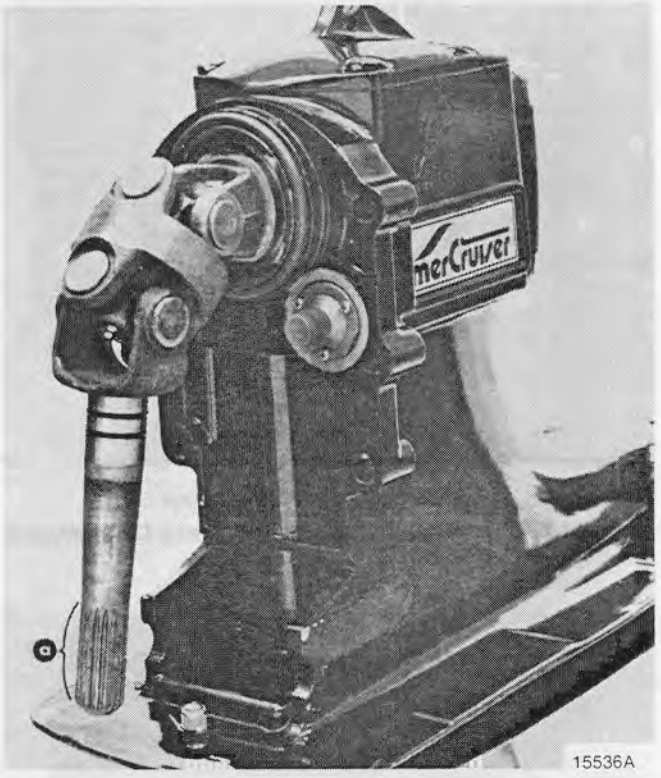
Figure 7. Typical MCM 120-260 Stern Drive Model



a - Quicksilver 2-4-C Multi-Lube

Figure 8. Typical MCM 120-260 Stern Drive Model

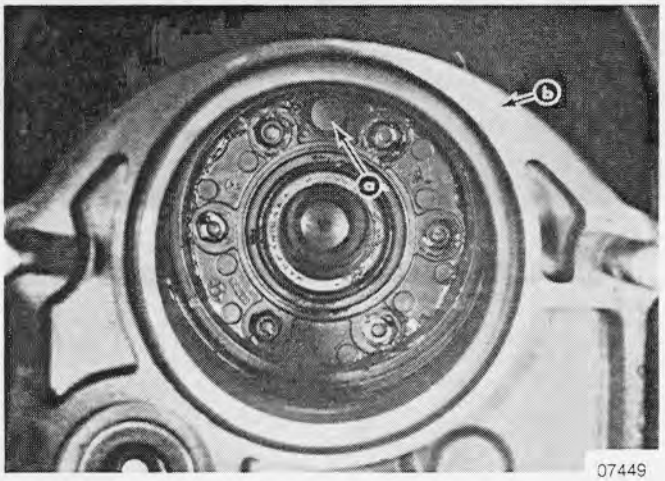
"U"-JOINT SHAFT SPLINE (STERN DRIVE MODELS WITH BORG-WARNER TRANSMISSION)



a - Quicksilver 2-4-C Multi-Lube

Figure 9. TR/TRS Stern Drive Unit

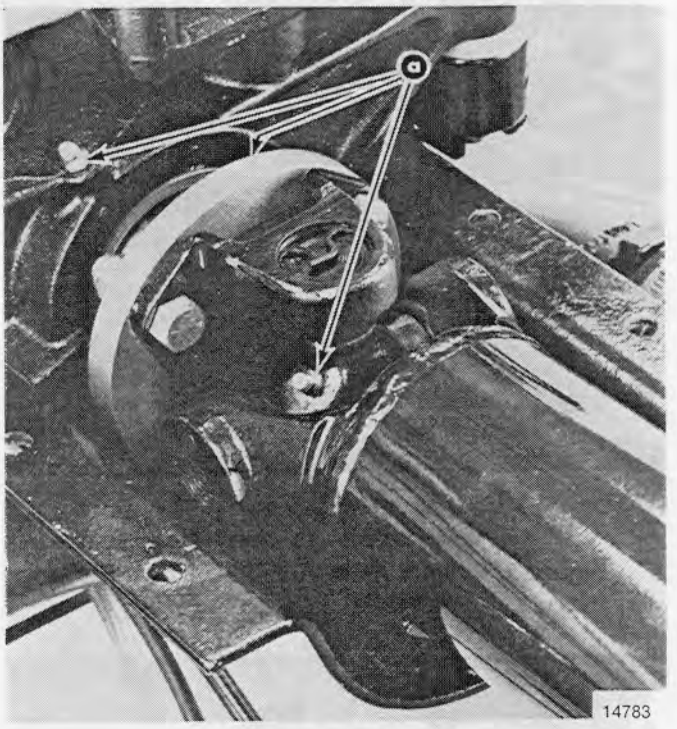
OUTPUT HOUSING (STERN DRIVE WITH MERCURY MARINE TRANSMISSION)



a - Quicksilver 2-4-C Multi-Lube
b - Bell Housing

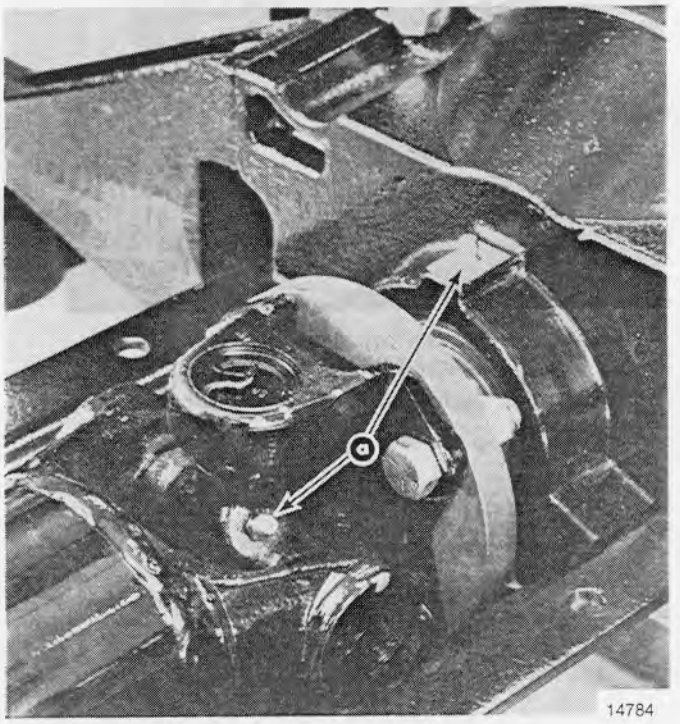
Figure 10. Transmission Output Housing Bearing

DRIVESHAFT EXTENSION MODELS (MCM 120R/140R and 898/228/260)



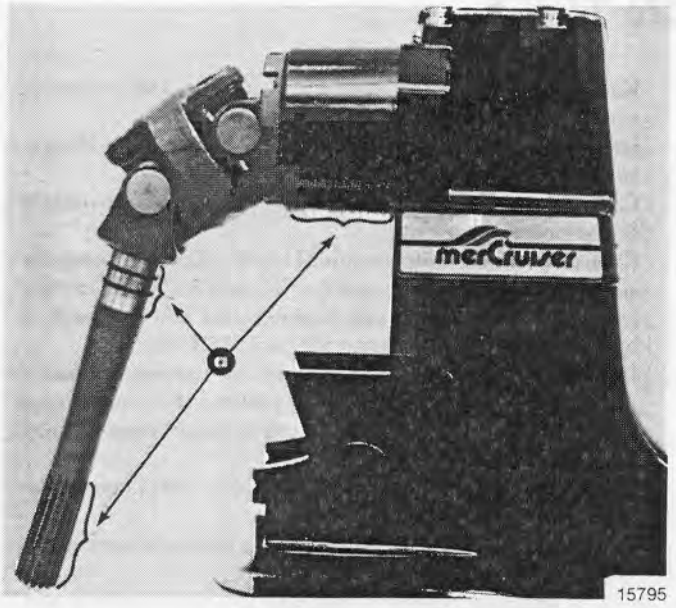
a - Quicksilver 2-4-C Multi-Lube

Figure 11. Transom End



a - Quicksilver 2-4-C Multi-Lube

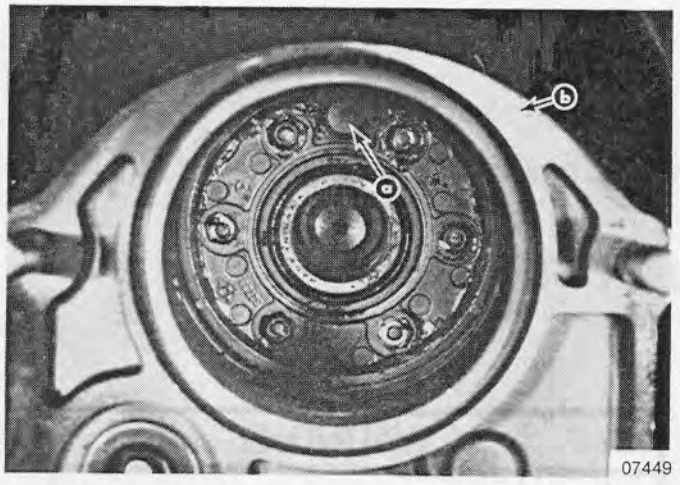
Figure 12. Engine End



a - Quicksilver 2-4-C Multi-Lube

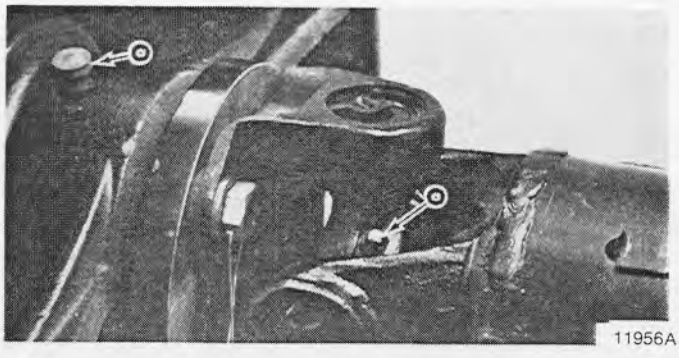
Figure 13. Stern Drive Unit

STAGGERED ENGINE (MCM 370 - 475 TURBO)



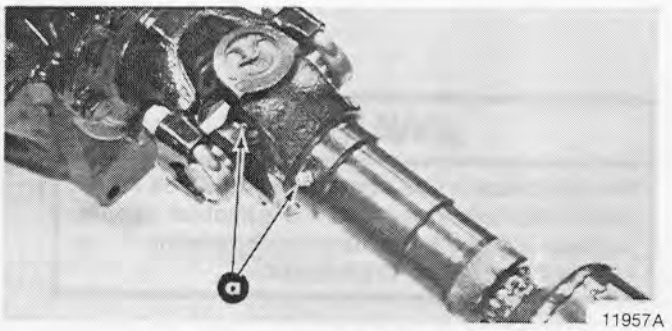
a - Quicksilver 2-4-C Multi-Lube
b - Bell Housing

Figure 14. Tailstock Assembly



a - Quicksilver 2-4-C Multi-Lube

Figure 15. Tailstock and Driveshaft (Transom End)



a - Quicksilver 2-4-C Multi-Lube

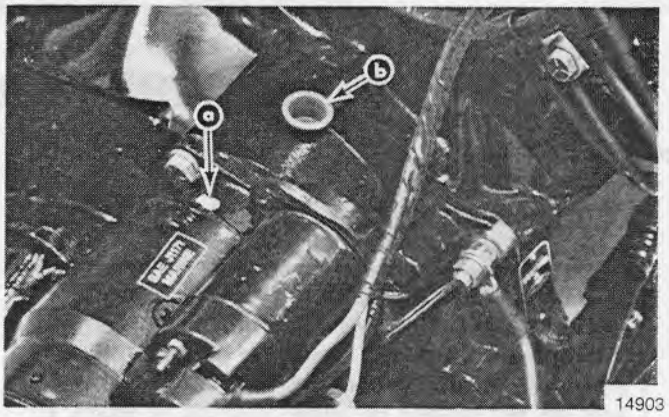
Figure 16. Driveshaft (Engine End)

STARTER MOTOR LUBRICATION
MCM 330 (B-W) and MIE 230/260/340 Only

⚠WARNING

When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of a fire.**
- **Be sure to keep hands, feet and clothing clear of engine moving parts.**
- **Be sure to ground coil hi-tension wire to block. Failure to ground coil wire may cause damage to ignition coil, in addition to being a safety hazard.**



a - Remove ignition coil hi-tension wire from distributor cap tower and ground it to engine block with jumper wire. While cranking engine with starter motor, lubricate starter motor front bushing thru oil cover with Lubriplate Extra-Heavy Gear Shield or its equivalent. Reinstall coil hi-tension wire.

b - Remove plastic plug from flywheel housing. Lubricate starter motor shaft with Lubriplate Extra-Heavy Gear Shield thru hole in flywheel housing. Reinstall plastic plug.

Figure 17. Starter Motor

MCM 470TR/230TR/260TR

On these models, follow Figures 1 or 2, 4, 5, and 6 for lubrication.

STEERING SYSTEM/STERN DRIVE

Refer to "Stern Drive Service Manual"

COMPRESSION TEST

⚠WARNING

Be sure that engine compartment is well ventilated and that there are no gasoline vapors present during the following operation -- to prevent a potential fire hazard.

1. Remove and ground coil high tension lead from distributor cap tower. Remove any foreign matter from around plugs by blowing away with compressed air, then remove plugs.
2. Remove flame arrestor and block throttle and choke in wide open position.
3. Insert compression gauge firmly in spark plug port. (Figure 1)
4. Crank engine thru at least 4 compression strokes to obtain highest possible reading.
5. Check and record compression of each cylinder. Compression should read as indicated in "Tune-Up Chart" in this section. Variation between highest and lowest reading cylinders should be less than 20 psi (138 kPa).
6. If one or more cylinders read low or uneven, inject a tablespoon of engine oil on top of pistons thru spark plug port. Crank engine several times and recheck compression.
7. Checking results:
   a. If compression increases, but does not necessarily reach normal, rings are worn.
   b. If compression does not improve, valves are sticking or seating poorly.
   c. If 2 adjacent cylinders indicate low compression and injecting oil does not increase compression, the cause may be a head gasket leak between cylinders with resulting engine coolant and/or oil in cylinders.

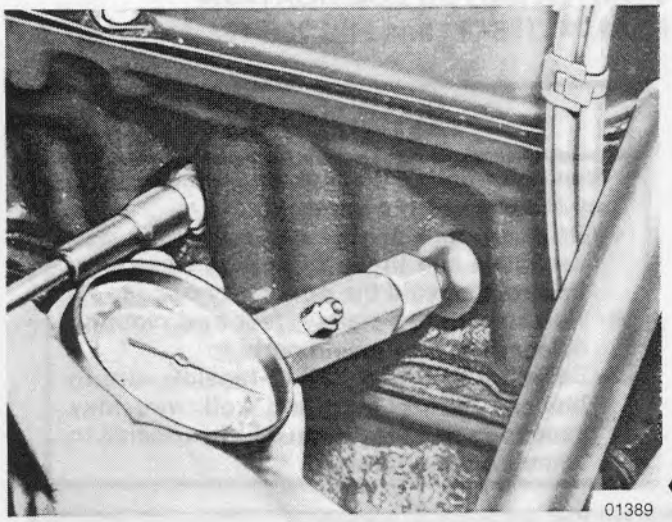


Figure 1. Checking Compression

OUT-OF-SEASON STORAGE

PRECAUTIONS

⚠WARNING

Be careful when changing fuel filters or while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF" and do not smoke or allow sources of spark and/or open flames in the area.

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present during starting or "Fogging" of engine — to prevent a potential fire hazard.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or water pump impeller will be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out-of-water, if "Flushing Cooling System", in "Section 1, Part B" are followed.

⚠CAUTION

Cooling System MUST BE COMPLETELY drained for storage, or trapped water may cause freeze and/or corrosion damage to engine. If engine has been exposed to freezing temperatures, the boat should be placed in a warm area before attempting to run engine or drain cooling system.

⚠CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section MUST BE kept filled with a solution of ethylene glycol anti-freeze and water (mixed to anti-freeze manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). SEAWATER SECTION, HOWEVER, MUST BE DRAINED COMPLETELY.

⚠CAUTION

A discharged battery can be damaged by freezing.

LAYUP

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Fill fuel tank(s) with fresh gasoline and a sufficient amount of Quicksilver Gasoline Stabilizer and Conditioner to treat the gasoline.

⚠CAUTION

If gasoline (in fuel tanks) contain alcohol and if boat is to be stored for a long period of time, carburetor must be run dry at idle RPM. Fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank.

2. Replace all fuel filters. ("Section 4")
3. Start engine and check for fuel leaks.
4. Run engine sufficiently to bring it up to normal operting temperature, then shut off engine and change oil and oil filter. ("Section 1, Part B")
5. **Models With Transmission:** Change transmission fluid. ("Section 8").
6. If boat has been operated in salty, polluted or mineral-laden waters, flush cooling system. ("Section 1, Part B")
7. Remove flame arrestor assembly and restart engine. While operating engine at fast idle (1000-1500 RPM), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or if not available, SAE 20 SE engine oil into carburetor bores. Stall engine by squirting last 2 ounces (57g) of Storage Seal or oil rapidly into carburetor. Turn ignition to "Off".
8. Close fuel shut off valve, if so equipped.
9. Clean flame arrestor and crankcase ventilation hoses and reinstall. ("Section 4")
10. Lubricate all items outlined in "Lubrication". ("Section 1, Part B")
11. Drain cooling system. ("Section 7")
12. **Closed Cooling System Models:** Check coolant (with anti-freeze tester) to ensure that solution is set for lowest temperature expected during storage.
13. Service battery(s). ("Section 3, Part A")
14. Clean outside of engine and repaint any surfaces, which have become bare with Quicksilver Primer and Quicksilver Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II on exterior surfaces of engine. If Corrosion and Rust Preventive Type II is not available, wipe down engine with a cloth that is saturated with Quicksilver Storage Seal or SAE 20 SE engine oil.
15. **Stern Drive Models:** Refer to "Stern Drive Service Manual".
16. **Inboard Models:** Disconnect propeller shaft coupling from transmission coupling.

RECOMMISSIONING

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Check that all cooling system hoses are connected properly, that drain plugs are installed and that petcocks are closed. ("Section 7")
2. Inspect all drive belts.
3. Check engine alignment. ("Section 2")
4. Perform ALL lubrication and maintenance specified for completion "At Least Once Each Year" in "Maintenance Chart", except items which were performed at time of engine layup. ("Section 1, Part B")
5. **Stern Drive Models:** If removed, install stern drive unit. ("Stern Drive Service Manual").
6. **Inboard Models:** Reconnect propeller shaft coupling. ("Section 2, Part I")

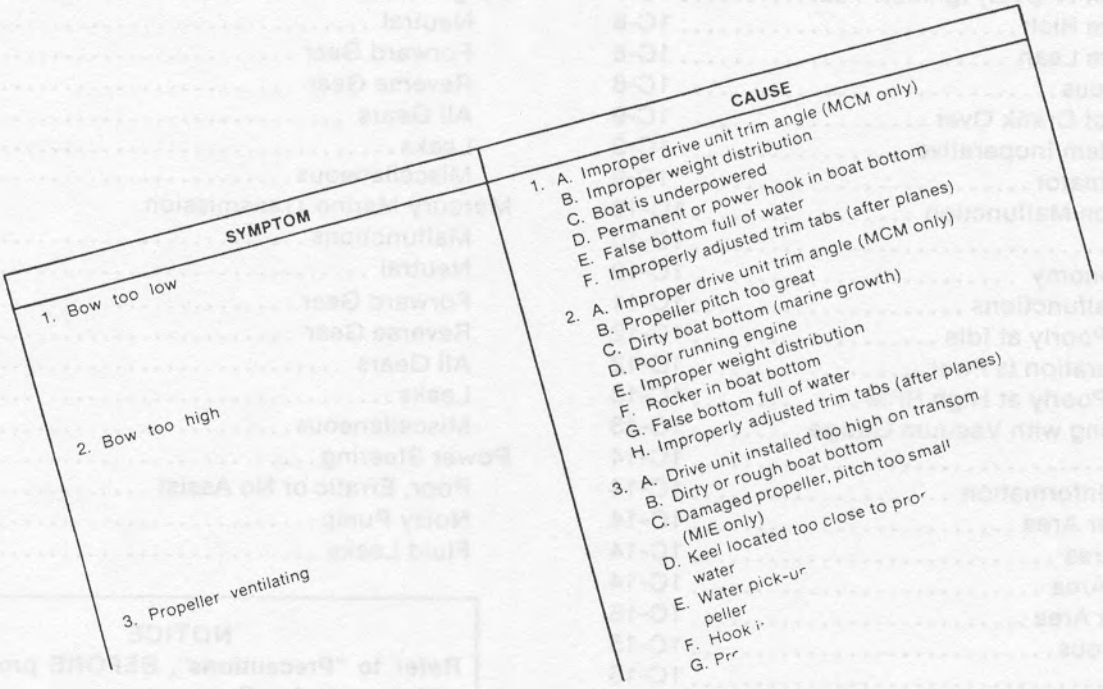
⚠CAUTION

When installing battery (in next step), be sure to connect negative (grounded) battery cable to negative (-) battery terminal and positive battery cable to positive (+) terminal. If battery cables are reversed, damage to electrical system WILL result.

7. Install fully-charged battery. Clean battery cable clamps and terminals and reconnect cables. Be sure to tighten clamps securely. Apply a thin coat of petroleum base grease to clamps and terminals to help retard corrosion.
8. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
9. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
10. Check fuel pump sight tube (or glass). ("Section 4")
11. Check steering system and shift and throttle control for proper operation.

SECTION 1 - IMPORTANT INFORMATION/ TROUBLESHOOTING

PART C - TROUBLESHOOTING



SYMPTOM	CAUSE
1. Bow too low	1. A. Improper drive unit trim angle (MCM only) B. Improper weight distribution C. Boat is underpowered D. Permanent or power hook in boat bottom E. False bottom full of water F. Improperly adjusted trim tabs (after planes)
2. Bow too high	2. A. Improper drive unit trim angle (MCM only) B. Propeller pitch too great C. Dirty boat bottom (marine growth) D. Poor running engine E. Improper weight distribution F. Rocker in boat bottom G. False bottom full of water H. Improperly adjusted trim tabs (after planes)
3. Propeller ventilating	3. A. Drive unit installed too high on transom B. Dirty or rough boat bottom C. Damaged propeller, pitch too small (MIE only) D. Keel located too close to pro E. Water pick-u peller F. Hook i G. Pr

MERCURY MARINE
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mercruiser
STERN DRIVES & INBOARDS

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NOTICE

Refer to "Precautions", BEFORE proceeding with troubleshooting.

PRECAUTIONS

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump on engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out-of-water, if instructions, under "Flushing Cooling System" in "Section 7, Part A" are followed.

⚠WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠CAUTION

DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

⚠WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE.

⚠WARNING

DO NOT leave helm unattended while performing tests.

USED SPARK PLUG ANALYSIS

Use the following illustrations to help reach a decision that plug is or is not serviceable and can be restored by cleaning, filing and regapping. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, entire set should be replaced. Plug service should be performed only on those plugs suitable for additional service, using the following procedures:

- Remove any oil deposits with solvent and dry plugs thoroughly.
- Open electrode gap wide enough to permit cleaning and filing.
- Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.
- File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.
- Reset gap to specifications by bending only side electrode with proper tool.

NORMAL CONDITION

Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and regap), this plug can be reinstalled with good results.

08958

Figure 1. Normal Condition

CHIPPED INSULATOR

Chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split insulator firing ends. Plug must be replaced.

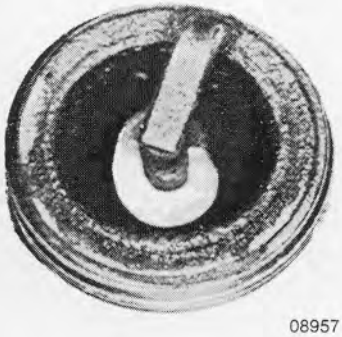

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Figure 2. Chipped Insulator

WET FOULING (OIL DEPOSITS)

Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and regap) and reinstalled.

08958

Figure 3. Wet Fouling (Oil Deposits)

COLD FOULING

Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If only one or two plugs in set are fouled, however, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and regap) plugs and reinstall.

08958

Figure 4. Cold Fouling

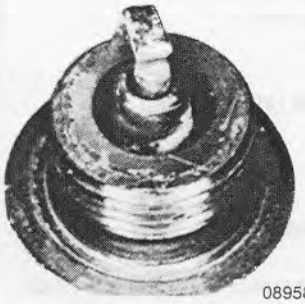
OVERHEATING

Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. (Sec. 8) Also check over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.

08957 **Figure 5. Overheating**

HIGH SPEED GLAZING

Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition re-occurs, use colder heat range plug and service plugs more frequently.



08958 **Figure 6. High Speed Glazing**

SCAVENGER DEPOSITS

Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is normal appearance with certain branded fuels. Accumulation on ground electrode and shell areas may be unusually heavy, but may be easily chipped off. Plugs can be serviced (clean, file and regap) and reinstalled.

08958 **Figure 7. Scavenger Deposits**

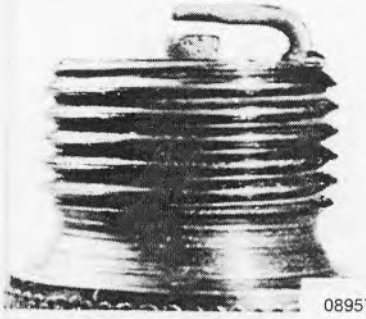
PRE-IGNITION DAMAGE

Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication.

08957 **Figure 8. Pre-Ignition Damage**

REVERSED COIL POLARITY

Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



08957 **Figure 9. Reversed Coil Polarity**

SPLASHED DEPOSITS

Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Clean and service plugs and reinstall.

08958 **Figure 10. Splashed Deposits**

MECHANICAL DAMAGE

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust manifold to prevent further damage.

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

Figure 11. Mechanical Damage

POOR BOAT PERFORMANCE and/or POOR MANEUVERABILITY

SYMPTOM	CAUSE
1. Bow too low	1. A. Improper drive unit trim angle (MCM only) B. Improper weight distribution C. Boat is underpowered D. False bottom full of water E. Improperly adjusted trim tabs (after planes) F. Permanent or power hook in boat bottom
2. Bow too high	2. A. Improper drive unit trim angle (MCM only) B. Dirty boat bottom (marine growth) C. Improper weight distribution D. False bottom full of water E. Improperly adjusted trim tabs (after planes) F. Rocker in boat bottom G. Propeller pitch too great H. Poor running engine
3. Propeller ventilating	3. A. Propeller plugged up with weeds B. Dirty or rough boat bottom C. Damaged propeller, pitch too small, diameter too small (MIE only) D. Keel located too close to propeller or too deep in the water E. Water pick-up or accessories located too close to propeller slip stream F. Hook in boat bottom G. Drive unit installed too high on transom (MCM only)

IMPROPER FULL THROTTLE ENGINE RPM

RPM TOO HIGH

CAUSE	SPECIAL INFORMATION
1. Propeller	1. Damaged, pitch too low, diameter too small (MIE), propeller hub slipping (MCM)
2. Boat	2. Water pick-up or accessories mounted too close to propeller slip stream, keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom, wrong gear ratio.
3. Operation	3. Unit trimmed out too far (MCM only).
4. Engine coupler slipping (MCM only)	

RPM TOO LOW

CAUSE	SPECIAL INFORMATION
1. Propeller	1. Damaged, pitch too great, diameter too great (MIE)
2. Boat	2. Dirty or damaged bottom, permanent or power hook in bottom, false bottom full of water. Drive installed too low on transom, wrong gear ratio.
3. Operation	3. Unit trimmed in too far (MCM only)

ENGINE CRANKS OVER BUT WILL NOT START OR STARTS HARD

IMPORTANT INFORMATION

1. The first thing that must be determined is which system on the engine is causing the problem. To make an engine run it takes 3 basic components - fuel, spark (ignition), and compression. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.
2. Determine if there is fuel present by looking down carburetor venturi while actuating throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
3. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure the plugs are correct type and heat range, and not fouled or burned.
4. Run a compression check on engine to make sure the engine is up to par mechanically.

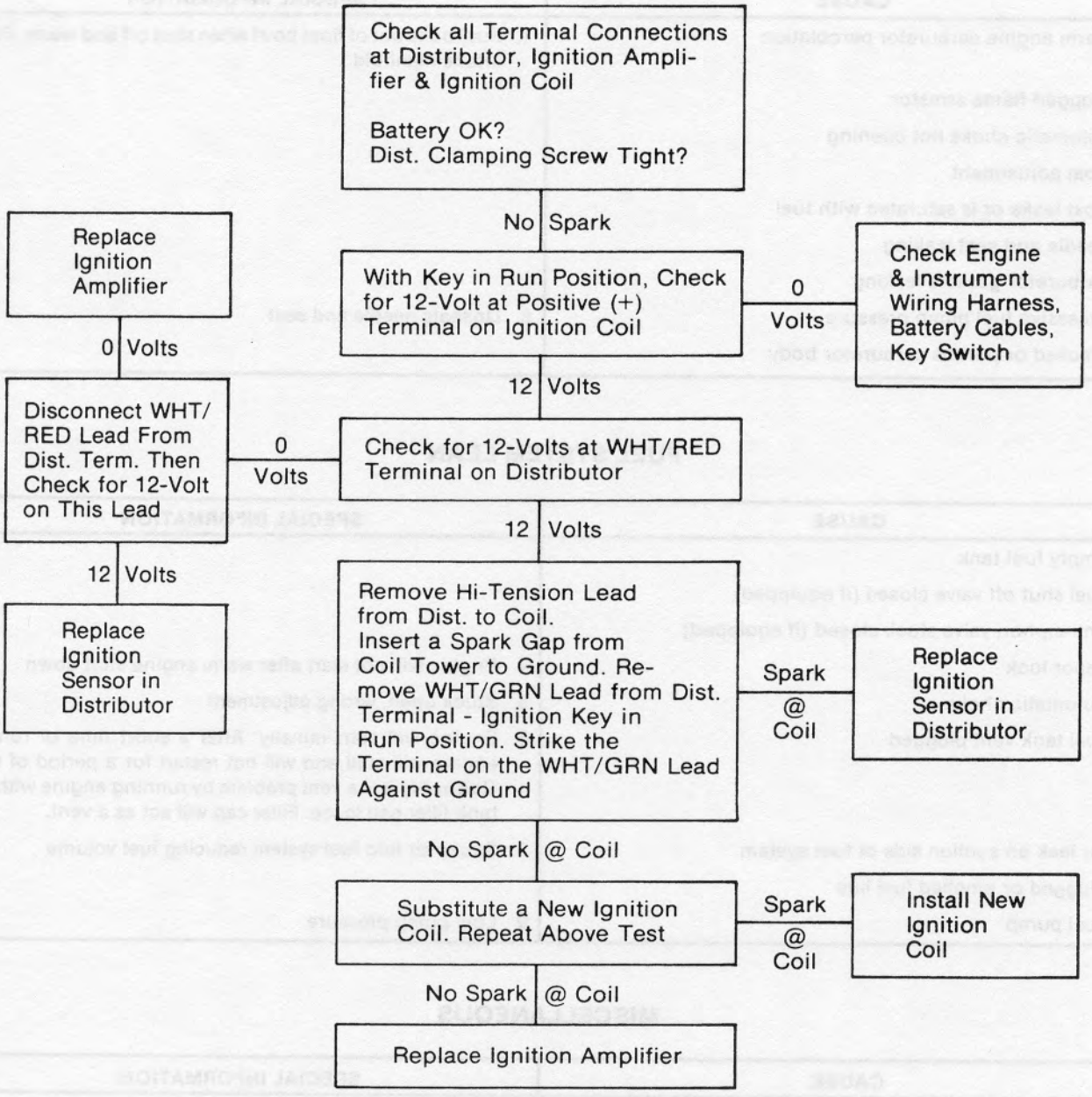
CONVENTIONAL IGNITION (NO SPARK)

CAUSE	SPECIAL INFORMATION
1. Moisture on ignition components	1. Distributor cap or spark plug leads arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	3. May run in start position and loose spark in the run position
4. Shift interruptor switch (MCM 120-260 only)	
5. Shorted tachometer	5. Disconnect tachometer and try again.
6. Ignition timing	6. May crank over hard, backfire, or try to run backwards
7. Faulty ignition resistor wire or bypass wire	
8. Ignition points improperly gapped, burned or dirty	
9. Spark plugs	9. Fouled, burned, cracked porcelain
10. Spark plug wires	10. Faulty insulation, broken wires
11. Cracked or dirty distributor cap or rotor	
12. Coil	
13. Condenser	

THUNDERBOLT IV (HEI) IGNITION (NO SPARK)

CAUSE	SPECIAL INFORMATION
1. Moisture on ignition components	1. Distributor cap or spark plug wires arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	
4. Shift interruptor switch (MCM 898R-260R)	
5. Shorted tachometer	5. Disconnect tachometer and try again
6. Ignition timing	
7. Spark plugs	7. Fouled, burned, cracked porcelain
8. Spark plug wires	8. Faulty insulation, broken wires
9. Cracked or dirty distributor cap	
10. Faulty ignition components	10. Refer to page 1C-7 to check components
11. Engine synchronizer (if equipped) hooked up in series on purple ignition wire (dual engines only)	11. Synchronizers must be hooked up directly at coil terminal (parallel circuit)

THUNDERBOLT IV (HEI) IGNITION TEST



FUEL SYSTEM RICH

CAUSE	SPECIAL INFORMATION
1. Warm engine carburetor percolation	1. Fuel boils out of float bowl when shut off and warm. Flood intake manifold.
2. Clogged flame arrestor	
3. Automatic choke not opening	
4. Float adjustment	
5. Float leaks or is saturated with fuel	
6. Needle and seat leaking	
7. Carburetor gaskets leaking	
8. Excessive fuel pump pressure	8. Unseats needle and seat
9. Cracked or porous carburetor body	

FUEL SYSTEM LEAN

CAUSE	SPECIAL INFORMATION
1. Empty fuel tank	
2. Fuel shut off valve closed (if equipped)	
3. Anti-siphon valve stuck closed (if equipped)	
4. Vapor lock	4. Engine will not start after warm engine shut down
5. Automatic choke	5. Stuck open, wrong adjustment
6. Fuel tank vent plugged	6. Engine will start initially. After a short time of running engine will stall and will not restart for a period of time. Can verify it is a vent problem by running engine with fuel tank filler cap loose. Filler cap will act as a vent.
7. Air leak on suction side of fuel system	7. Sucks air into fuel system reducing fuel volume
8. Plugged or pinched fuel line	
9. Fuel pump	9. Low pump pressure

MISCELLANEOUS

CAUSE	SPECIAL INFORMATION
1. Low grade or stale fuel	
2. Water in fuel	
3. Vacuum leak	
4. Low compression	4. Worn valves, rings, cylinder, or head gasket
5. Valve timing incorrect	5. Timing chain or gears jumped or improperly installed

ENGINE WILL NOT CRANK OVER

CAUSE	SPECIAL INFORMATION
1. Control lever not in neutral position	
2. Battery charge low, damaged wiring, loose electrical connections	
3. Blown fuse at starter motor (if so equipped)	3. Early models with red wire going to fuse on starter terminal only
4. Circuit breaker tripped	
5. Ignition switch	
6. Slave solenoid (GM engines only)	
7. Faulty neutral start safety switch	7. Open circuit
8. Starter solenoid	
9. Starter motor	

CHARGING SYSTEM INOPERATIVE

CAUSE	SPECIAL INFORMATION
1. Loose or broken drive belt	
2. Engine RPM too low on initial start	2. Rev engine to 1500 RPM
3. Loose or corroded electrical connections	
4. Faulty ammeter or battery gauge	4. Best way to test is to replace gauge
5. Battery will not accept charge	5. Low electrolyte, failed battery
6. Faulty alternator or regulator	
7. Failed fuse (if so equipped)	7. Fuse located on starter terminal stud. Orange output wire from alternator connects to fuse.
8. Refer to "Section 3, Part C" for complete troubleshooting procedures.	

NOISY ALTERNATOR

CAUSE	SPECIAL INFORMATION
1. Loose mounting bolts	
2. Drive belt	2. Worn, frayed, loose
3. Loose drive pulley	
4. Worn or dirty bearings	
5. Faulty diode trio or stator	

INSTRUMENTATION MALFUNCTION

CAUSE	SPECIAL INFORMATION
1. Faulty wiring, loose or corroded terminals	
2. Bad key switch	2. Test as outlined in "Section 3, Part D"
3. Faulty gauge	3. Test as outlined in "Section 3, Part D"
4. Faulty sender	4. Test as outlined in "Section 3, Part D"

RADIO NOISE

CAUSE	SPECIAL INFORMATION
1. A "popping" noise that will increase with engine RPM. Noise will stop as soon as engine is turned off.	1. Ignition System - wrong spark plugs, cracked distributor cap, cracked coil tower, leaking spark plug wires, moisture on ignition components.
2. "High pitched whine" in the radio	2. Alternator - poor brush contact on the slip rings
3. A "hissing or crackling" noise when instruments are jarred with ignition on	3. Instrumentation - loose connections, or antennae wire routed too close to instruments
4. Varying unexplained noises	4. Accessories - bilge pump, bilge blower, fish finder, depth locator, cabin heater motor, etc. Disconnect one at a time until noise disappears.

POOR FUEL ECONOMY

CAUSE	SPECIAL INFORMATION
1. Fuel leaks	
2. Operator habits	2. Prolonged idling, slow acceleration, failure to cut back on throttle once boat is on plane, boat overloaded, uneven weight distribution
3. Engine laboring	3. Bent, damaged, wrong propeller. Water test boat for proper operating RPM at WOT.
4. Clogged flame arrestor	
5. Engine compartments sealed too tight	
6. Boat bottom	6. Dirty (marine growth), hook, rocker
7. Carburetor	7. Idle mixture settings, accelerator pump adjustment, linkage binding, choke adjustment, carburetor flooding over, main fuel jets
8. Improper fuel	
9. Crankcase ventilation system not working	
10. Engine needs tune-up	
11. Engine running too cold or too hot	
12. Plugged or restricted exhaust	
13. Engine	13. Low on compression

CARBURETOR MALFUNCTIONS

SYMPTOM	CAUSE
1. Flooding	1. A. Needle and seat B. Float adjustment C. Saturated float D. Gaskets leaking E. Cracked fuel bowl F. Fuel percolation G. Automatic choke
2. Rough idle	2. A. Idle RPM too low B. Idle mixture screws C. Idle passages dirty D. Throttle valves not closing E. Engine flooding F. Vacuum leak G. Throttle body heat passages plugged
3. Hesitation or acceleration flatness	3. A. Accelerator pump B. Leaking gaskets C. Automatic choke D. Power piston or power valve E. Throttle valves F. Throttle body heat passages plugged G. Main metering jets H. Float adjustment I. Secondary air valve wind-up
4. Engine surges	4. A. Main metering jets B. Leaking gaskets C. Float adjustment D. Saturated float E. Power piston or valve F. Throttle valves
5. Low top speed or lack of power	5. A. Power piston or valve B. Float adjustment C. Main metering jets D. Leaking gaskets
6. Poor cold engine operation	6. A. Idle RPM too low B. Idle mixture screws C. Throttle valves D. Automatic choke E. Engine flooding
7. Engine stalls	7. A. Idle RPM too low B. Idle mixture screws C. Engine flooding D. Automatic choke E. Dirt in carburetor F. Accelerator pump G. Leaking gaskets
8. Hard starting	8. Refer to page 1C-6

ENGINE RUNS POORLY AT IDLE

CAUSE	SPECIAL INFORMATION
1. Clogged flame arrestor	
2. Improper idle fuel mixture adjustment	
3. Moisture on ignition components	3. Cap or spark plug wires arcing
4. Water in fuel	
5. Low grade or stale fuel	
6. Incorrect ignition timing	
7. Automatic choke	
8. Spark plugs	8. Fouled, burned, cracked porcelain
9. Incorrect point gap, burned or pitted points	
10. Spark plug wires	10. Insulation break down, wires broken
11. Defective coil or condenser	
12. Cracked or dirty distributor cap	
13. Incorrect float level	
14. Dirty carburetor	
15. Vacuum leak	15. Leak at manifold or carburetor base
16. Incorrect fuel pump pressure	16. Too low, can't supply the carburetor Too high, unseats the needle and seat
17. Low compression	17. Also check for blown head gasket
18. Loose or worn distributor	18. Timing and/or dwell changes
19. Water leaking into cylinders	19. Head gasket, exhaust manifold, cracked head or valve seat
20. Loose or broken engine mounts	

ENGINE ACCELERATION IS POOR

CAUSE	SPECIAL INFORMATION
1. Also refer to "Poor Boat Performance", page 1C-4	
2. Idle mixture screws	
3. Air valve spring out of adjustment	3. Rochester 4 barrel carb only
4. Incorrect ignition timing	
5. Incorrect distributor or amplifier advance curve	5. Refer to "Section 3, Part B"
6. Accelerator pump	6. Check for stream of raw fuel from accelerator pump discharge nozzle, when opening throttle with engine shut off
7. Cracked or dirty distributor cap or rotor	
8. Vacuum leak	8. Manifold or carburetor base
9. Spark plugs	9. Fouled, burned, wrong heat range, cracked porcelain
10. Incorrect point gap, dirty or burned points	
11. Float adjustment	
12. Dirty carburetor	
13. Low compression	

ENGINE RUNS POORLY AT HIGH RPM

CAUSE	SPECIAL INFORMATION
1. Also refer to "Poor Boat Performance", page 1C-4	
2. Crankcase over-filled with oil	2. Check oil level with boat at rest in the water. Refer to "Section 1, Part B"
3. Anti-siphon valve (if equipped)	3. Restricting fuel supply
4. Plugged fuel tank vent	
5. Fuel supply	5. Refer to page 1C-11
6. Ignition timing	
7. Low grade of fuel or water in the fuel	
8. Spark plugs	8. Fouled, burned, cracked, porcelain, heat range
9. Spark plug wires	9. Poor insulation, broken wires
10. Distributor cap or rotor	10. Dirty or cracked
11. Coil	
12. Distributor	12. Points, condenser, worn cam, excessive play in shaft
13. Engine overheating	13. Refer to page 1C-19 or 1C-20
14. Low compression	14. Worn valves, rings, cylinders, etc.
15. Restricted exhaust	

TROUBLESHOOTING WITH VACUUM GAUGE

READING	CAUSE
1. Steady reading betweeen 15-21 inches at idle RPM	1. Normal
2. Extremely low reading, but steady at idle RPM	2. Vacuum leak, incorrect timing, under powered boat, faulty boat bottom
3. Fluctuates between high and low at idle RPM	3. Blown head gasket between 2 adjacent cylinders
4. Fluctuates 4 or 5 inches very slowly at idle RPM	4. Carburetor needs adjustment, spark plug gap too narrow, valves are sticking
5. Fluctuates rapidly at idle, steadies as RPM is increased	5. Valve guides are worn
6. Continuously fluctuates between low and normal reading at regular intervals at idle RPM	6. Burned or leaking valve

ENGINE NOISE

IMPORTANT INFORMATION

No definite rule or test will positively determine source of engine noise; therefore, the following information should be used only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed, are related to crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine. Front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples of this would be, loose flywheel or coupler, exhaust flappers rattling against exhaust pipe, crankshaft striking (pan, pan baffle, or dipstick tube), rocker arm striking valve cover, and loose flywheel cover. In many cases if this is found to be the problem a complete engine tear down is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine or drive unit, remove drive from boat. Run a water supply directly to engine, then run engine without the drive to determine if noise is still there.

VALVE COVER AREA

LOCATION	POSSIBLE CAUSES
1. Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders.	1. A. Rocker arm striking valve cover B. Rocker arm out of adjustment C. Worn rocker arm D. Bent push rod E. Collapsed lifter

CYLINDER AREA

LOCATION	POSSIBLE CAUSES
1. Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	1. A. Sticking valve B. Carbon build up C. Connecting rod installed wrong D. Bent connecting rod E. Piston F. Piston rings G. Piston pin H. Cylinder worn

CAMSHAFT AREA

LOCATION	POSSIBLE CAUSES
1. Camshaft area, front of engine, timed to one-half engine speed	1. A. Camshaft timing sprocket or gear B. Timing chain C. Fuel pump (V-8 only), Distributor Gear (4 & 6 cylinder only) D. Valve lifter E. Cam bearings
2. Camshaft area, center of engine, timed to one-half engine speed	2. A. Fuel pump (4 & 6 cylinder only) B. Valve lifter C. Cam bearings
3. Camshaft area, rear of engine, timed to one-half engine speed	3. A. Distributor gear (V-8 only) B. Valve lifter C. Cam bearings
4. Camshaft area, throughout engine, timed to one-half engine speed	4. A. Loss of oil pressure B. Valve lifters C. Cam bearings

CRANKSHAFT AREA

LOCATION	POSSIBLE CAUSES
1. Crankshaft area, front of engine, timed to engine speed	1. A. Crankshaft timing sprocket or gear B. Timing chain C. Main bearing D. Rod bearing
2. Crankshaft area, center of engine, timed to engine speed	2. A. Crankshaft striking pan or pan baffle B. Main bearing C. Rod bearing
3. Crankshaft area, rear of engine, timed to engine speed	3. A. Loose flywheel cover B. Loose coupler C. Loose flywheel D. Drive plate E. Main bearing F. Rod bearing
4. Crankshaft area, throughout engine, timed to engine speed	4. A. Loss of oil pressure B. Main bearings C. Rod bearings

MISCELLANEOUS

NOISE	POSSIBLE CAUSE
1. Engine spark knock	1. A. Advanced timing B. Low octane fuel C. Engine running hot D. Carbon deposits in engine
2. Popping through carburetor	2. A. Wrong ignition timing B. Carburetor set up too lean C. Faulty accelerator pump D. Vacuum leak E. Valve adjustment F. Valve timing G. Burned or stuck valve
3. Hissing	3. A. Vacuum leak B. Fuel pump (hissing in sight tube) C. Leaking exhaust (manifolds or pipes) D. Loose cylinder heads E. Blown head gasket
4. Whistle	4. A. Vacuum leak B. Dry or tight bearing in an accessory
5. Sparks jumping	5. A. Leaking high tension lead B. Cracked coil tower C. Cracked distributor cap
6. Squeaks or squeals	6. A. Drive belt slipping B. Dry or tight bearing in an accessory C. Parts rubbing together
7. Rattling in exhaust pipe area	7. A. Exhaust shutters

OIL PRESSURE

NOTICE
Refer to "Section 1, Part B" for minimum oil pressure readings.

IMPORTANT INFORMATION

1. Measuring oil pressure	1. Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
2. Check engine oil level with boat at rest in the water	2. Oil level should be between the add and full marks. DO NOT over fill.
3. Oil level in crankcase above full mark	3. May cause loss of engine RPM, oil pressure gauge flucuation, drop in oil pressure, and hydraulic valve lifter noise at high RPM
4. Oil level in crankcase below add mark	4. Low oil pressure, oil pressure gauge flucuation, internal engine noise and/or damage
5. Change in oil pressure	5. This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal operating temperature, it is normal for oil pressure to drop off slightly.
6. Low engine oil pressure at idle	6. With modern engines and engine oils, low oil pressure readings at idle does not necessarily mean there is a problem. If valve lifters do not "clatter" (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and also the oil will thin out somewhat from heat.
7. Low engine oil pressure at idle after running at a high RPM	7. Refer to "No. 5 and 6" preceding
8. Boats with dual engines	8. It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
9. Boats with dual stations	9. Refer to "No. 8" preceding

LOW OIL PRESSURE

NOTICE
Refer to "Section 1, Part B" for minimum oil pressure readings.

CAUSE	SPECIAL INFORMATION
1. Low oil level in crankcase	
2. Defective oil pressure gauge and/or sender	2. Verify reading with an automotive test gauge. Refer to "Section 3, Part D" for instrument testing.
3. Thin or diluted oil	3. Oil broken down, contains water or gas, wrong viscosity, engine running too hot or too cold, excessive idling in cold water (condensation)
4. Oil pump	4. Relief valve stuck open, pick-up tube restricted, worn parts in oil pump, air leak on suction side of oil pump or pick-up tube
5. Oil leak, can be internal or external	5. Oil passage plugs leaking, cracked or porous cylinder block
6. Excessive bearing clearance	6. Cam bearings, main bearings, rod bearings

HIGH OIL PRESSURE

CAUSE	SPECIAL INFORMATION
1. Oil too thick	1. Wrong viscosity, oil full of sludge or tar
2. Defective oil pressure gauge and/or sender	2. Verify with an automotive test gauge **IMPORTANT: Oil pressure slightly higher than normal does not always mean there is a problem. Tolerance stack-up in the engine, oil viscosity, and weather conditions could cause high oil pressure.**
3. Clogged or restricted oil passage	
4. Oil pump relief valve stuck closed	

EXCESSIVE OIL CONSUMPTION

CAUSE	SPECIAL INFORMATION
1. Normal consumption	1. One quart of oil consumed in 5-15 hours of operation at WOT (especially in a new or rebuilt engine) is normal
2. Oil leaks	2. Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
3. Oil too thin	3. Oil diluted or wrong viscosity
4. Oil level too high	
5. Drain holes in cylinder head plugged	5. Oil will flood valve guides
6. Defective valve seals	
7. Intake manifold gasket leaking	7. Mercury Marine and GM V-8 engines only
8. Worn valve stems or valve guides	
9. Defective oil cooler (if so equipped)	9. Crack in cooler tubes
10. Defective piston rings	10. Glazed, scuffed, worn, stuck, improperly installed, ring grooves worn, improper break-in, wrong end gap
11. Defective cylinders	11. Out of round, scored, tapered, glazed, excessive piston to cylinder clearance, cracked piston
12. Excessive bearing clearance	

WATER IN ENGINE

IMPORTANT INFORMATION

IMPORTANT: The first thing that must be determined is where in the engine the water is located. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are "water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons".

The first step, after the water is located, is to remove all the water from the engine by removing all spark plugs and pump cylinders out by cranking engine over. Next change oil and filter. Now start engine and see if the problem can be duplicated. If problem can be duplicated, more than likely it is a mechanical problem of some sort. If the problem cannot be duplicated the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained in cylinder(s) only, it usually has entered through the intake system, exhaust system, or head gasket.

If the water is contained in crankcase only, it usually is caused by a cracked or porous block, a flooded bilge, or condensation.

If the water is located in both the cylinder(s) and the crankcase, it usually is caused by water in the cylinders getting past the rings and valves, or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered through these areas.

WATER ON TOP OF PISTONS

CAUSE	SPECIAL INFORMATION
1. Operator shut engine off at high RPM	
2. Engine "diesels" or trys to run backwards	2. Engine out of tune, poor fuel, high idle RPM, timing set too high
3. Rain water running into flame arrestor	3. Hatch cover
4. Spark plug misfiring	4. Improper combustion causes moisture in the air to accumulate in the cylinder
5. Backwash through the exhaust system	
6. Improper engine or exhaust hose installation	6. Refer to "Section 5, Part C" for exhaust specifications
7. Cracked exhaust manifold	
8. Improper manifold to elbow gasket installation	
9. Loose cylinder head bolts	
10. Blown cylinder head gasket	10. Check for warped cylinder head or cylinder block
11. Cracked valve seat	
12. Porous or cracked casting	12. Check cylinder heads, cylinder block, and intake manifold (Mercury Marine and GM V-8 engines)

WATER IN CRANKCASE OIL

CAUSE	SYMPTOM
1. Water in boat bilge	1. Boat has been submerged or bilge water was high enough to run in through dipstick tube.
2. Water seeping past piston rings or valves	2. Refer to "Water On Top Of Pistons"
3. Engine running cold	3. Defective thermostat, missing thermostat, prolonged idling in cold water
4. Intake manifold leaking near a water passage	
5. Cracked or porous casting	5. Check cylinder head, cylinder block, and intake manifold on (488 and GM V-8 engines)

ENGINE OVERHEATS (MECHANICAL)

CAUSE	SPECIAL INFORMATION
1. Engine RPM below recommendations at WOT (engine laboring)	1. Damage or wrong propeller, growth on boat bottom, false bottom full of water
2. Wrong ignition timing	2. Timing too far advanced
3. Sticking distributor advance weights	
4. Spark plug wires crossed (wrong firing order)	
5. Lean fuel mixture	5. Refer to page 1C-11
6. Wrong heat range spark plugs	
7. Exhaust restriction	
8. Valve timing off	8. Jumped timing chain and/or gears or improperly installed
9. Blown head gasket(s)	9. A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low RPM, but will overheat at speeds above 3000 RPM. **GM engines that are seawater cooled:** Using a clear plastic hose, look for air bubbles between seawater pump and engine. If there are no bubbles present, install clear plastic hose between thermostat housing and manifold(s). If air bubbles are present at a higher RPM it is a good indication there is a blown head gasket. **470/485/488:** Refer to "Section 7, Part B". **All other models with closed cooling:** Refer to "Section 7, Part B".
10. Insufficient lubrication to moving parts of engine	10. Defective oil pump, plugged oil passage, low oil level

ENGINE OVERHEATS (COOLING SYSTEM)

CAUSE	SPECIAL INFORMATION
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty.	**IMPORTANT: Best way to test gauge or sender is to replace them.**
1. Loose or broken drive belt	
2. Seawater shut-off valve partially or fully closed (if equipped)	2. Refer to "Section 7, Part A"
3. Clogged or improperly installed sea strainer	3. Refer to "Section 7, Part A"
4. Loose hose connections between seawater pick-up and seawater pump inlet. (Models with belt driven seawater pump only)	4. Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
5. Seawater inlet hose kinked or collapsed	
6. Improper installation of the hot water heater (if equipped)	6. 470/485/488 refer to "Section 7, Part B", all other models refer to "Section 7, Part A"
7. Seawater pick-up clogged	
8. Obstruction on boat bottom causing water turbulence	8. Obstruction will be in front of seawater pick-up, causing air bubbles to be forced into cooling system.
9. Defective thermostat	
10. Exhaust elbow water outlet holes plugged	
11. Insufficient seawater pump operation	11. Worn pump impeller
12. Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	12. Refer to water flow diagram for engine being serviced
13. Engine circulating pump defective	
14. Also refer to "Engine Overheats (Mechanical)"	
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
15. Low coolant level	
16. Anti-freeze not mixed properly	16. Anti-freeze should be mixed 50/50 or maximum 60/40 (60% anti-freeze, 40% water)
17. Heat exchanger cores plugged	
18. Water hoses reversed at the water distribution block	18. Refer to water flow diagrams "Section 7, Part C"
19. For further testing of the closed cooling system	19. 470/485/488 - refer to "Section 7, Part B" All other models - refer to "Section 7, Part C"

INSUFFICIENT WATER FLOW FROM MC-I STERN DRIVE UNIT SEAWATER PICKUP PUMP

CAUSE	SPECIAL INFORMATION
1. Seawater shut-off valve partially or fully closed (if equipped)	
2. Water pickups clogged with foreign material	
3. Kinked or broken bell housing-to-gimbal housing water tube hose	
4. Corroded thru gimbal housing water tube	
5. Water pickup inserts warped. (Engine will overheat while boat is underway only.)	5. Pickup inserts must not protrude above gear housing surface or inserts will create an irregular or turbulent water flow over the water pickup holes. This condition also can be identified by cavitation burn (pitting, erosion) on the gear housing in the area aft of the water pickup inserts.
6. Damaged gear housing or accessories improperly installed on boat bottom or transom (speedometer pickup, depth sounder transducer, etc.). Substantial amount of barnacles or other marine growth on gear housing or boat bottom. (Engine will overheat while underway only.)	6. An object or an irregularity on boat or gear housing in area close to water pickups could create turbulence in water flow going to water pickups. This could aerate the water flow and cause engine to overheat.
7. Stern drive installed too high on transom or drive unit trimmed too far out allowing air to be drawn into pump. (Engine will overheat while underway only.)	7. Contact boat company if stern drive is installed too high. Instruct operator on proper trimming technique if unit is trimmed out too far.
8. Bell housing-to-drive shaft housing "O" ring missing or damaged	
9. Faulty seawater pickup pump	
10. Seawater pickup pump water tube corroded thru	
11. Drive shaft housing water pocket cover cracked	
12. Broken-off impeller blade or other obstruction in water passages (usually lodges in drive shaft housing water pocket cover or cross-drilled water passage).	12. To check cross-drilled water passage in drive shaft housing, remove welch plug and pipe plug located under decal on starboard side of housing. Drive unit must be shifted into reverse to remove pipe plug.
13. Water passage in drive shaft housing improperly drilled	

INSUFFICIENT WATER FLOW FROM BELT DRIVEN SEAWATER PICKUP PUMP

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Loose or broken
2. Seawater shut-off valve partially or fully closed	2. Refer to "Section 7, Part A"
3. Clogged or improperly installed sea strainer	3. Refer to "Section 7, Part A"
4. Loose hose connections between seawater pickup and seawater pump inlet	4. Pump will suck air, pump may fail to prime or will force air bubbles into cooling system
5. Seawater inlet hose kinked or plugged	
6. Seawater pickup clogged	
7. Obstruction on boat bottom causing water turbulence	7. Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
8. Faulty seawater pump	

BORG-WARNER TRANSMISSION MALFUNCTIONS

NEUTRAL

SYMPTOM	CAUSE
1. Output shaft drags excessively in forward rotation	1. A. Shift linkage improperly adjusted B. Forward clutch improperly assembled C. Damaged or broken belleville clutch springs D. Damaged forward clutch plate(s)
2. Output shaft drags excessively in reverse rotation	2. A. Shift linkage improperly adjusted B. Reverse clutch plate improperly assembled C. Damaged reverse clutch plate(s) D. Damaged or broken clutch springs E. Planetary gear failure

FORWARD GEAR

SYMPTOM	CAUSE
1. Low fluid pressure	1. A. Dirty fluid screen B. Low fluid level C. Faulty regulator valve D. Worn fluid pump
2. Forward clutch engages improperly	2. A. Shift linkage improperly adjusted B. Sheared forward clutch hub drive key C. Worn or misaligned bushings in transmission case D. Worn or damaged clutch piston E. Oil seals and/or clutch sealing rings F. Clutch improperly assembled G. Damaged or broken belleville clutch spring H. Worn or damaged clutch plate(s)
3. Forward clutch plate slips (does not fully engaged)	3. A. Shift linkage improperly adjusted B. Clutch improperly assembled C. Damaged or broken belleville clutch spring D. Worn or damaged clutch plates
4. Reduction unit failure (inboard only)	4. A. Planetary gear failure

REVERSE GEAR

SYMPTOM	CAUSE
1. Low fluid pressure	1. A. Dirty fluid screen B. Low fluid level C. Faulty regulator valve D. Worn fluid pump
2. Reverse clutch engages improperly	2. A. Shift linkage improperly adjusted B. Worn or damaged clutch piston oil seals C. Reverse clutch improperly assembled D. Worn or damaged clutch plate(s) E. Damaged or broken clutch springs
3. Reverse clutch slips (does not engage fully)	3. A. Shift linkage improperly adjusted B. Reverse clutch improperly assembled C. Worn or damaged reverse clutch plate(s) D. Damaged or broken clutch springs
4. Reverse gear set failure	4. A. Planetary gear failure
5. Reduction gear failure	5. A. Planetary gear failure

ALL GEARS

SYMPTOM	CAUSE
1. No fluid pressure	1. No fluid, pump improperly installed for engine rotation, fluid pump drive key sheared
2. Low fluid pressure	2. Dirty fluid screen, low fluid level, faulty regulator valve, worn fluid pump
3. High fluid temperature	3. Water in transmission fluid from a damaged fluid cooler, low fluid level, high fluid level, low water supply to fluid cooler, plugged fluid cooler, planetary gear failure
4. Failure of reduction gear	4. Planetary gear failure

LEAKS

SYMPTOM	CAUSE
1. Fluid leaks at pump	1. Loose bolts, damaged gasket, damaged oil seal, foreign material on mating surfaces.
2. Fluid on exterior of transmission	2. Loose bolts or fluid line fittings, fluid filler cap leaks, damage "O" ring on control valve, damaged gasket, porous transmission housing, foreign material on mating surfaces
3. Fluid leaks at rear bearing retainer	3. Loose bolts, damaged gasket, damaged oil seal, foreign material on mating surfaces
4. Water in transmission fluid	4. Damaged fluid cooler

MISCELLANEOUS

SYMPTOM	CAUSE
1. Forward gear noise	1. Output shaft nut not torqued, nick on gears
2. Reverse gear noise	2. Output shaft nut not torqued, nick on gears, planetary gear failure
3. Pump noise	3. Low fluid level, worn fluid pump, nicks on gears
4. Shifts hard	4. Regulator valve stuck, shift linkage improperly adjusted, control lever and poppet ball corroded, shift linkage interference, damaged control valve "O" ring
5. High fluid pressure	5. Regulator valve stuck, wrong fluid used in transmission, cold fluid

MERCURY MARINE TRANSMISSION MALFUNCTIONS

NEUTRAL

SYMPTOM	CAUSE
1. Output shaft drags excessively in forward rotation	1. **Electric Shift Models** - Electric control box and/or shift motor not working properly **Manual Shift Models** - Control box not working or cables not adjusted properly **All Models** - Forward clutch pack not assembled properly, damaged forward clutch return spring, damaged clutch plates
2. Output shaft drags excessively in reverse rotation	2. Reverse clutch lever not free, incorrect reverse band adjustment, improperly assembled reverse clutch band assembly

FORWARD GEAR

SYMPTOM	CAUSE
1. Low fluid pressure	1. Low fluid level, dirty fluid screen, worn or misaligned output sleeve, damaged teflon seal rings, faulty fluid pump, fluid leaks, faulty relief valve
2. Forward clutch engages improperly	2. **Electric Shift Models** - Electric control box and/or shift motor not working properly **Manual Shift Models** - Control box not working or cables not adjusted properly **All Models** - Control valve assembled incorrectly, worn or misaligned output sleeve, damaged clutch piston oil seals, damaged teflon seal rings, forward clutch pack improperly assembled, damaged forward clutch return spring, worn or damaged clutch plates, broken piston housing
3. Forward clutch slips (does not fully engage)	3. **Electric Shift Models** - Control box and/or shift motor not working properly **Manual Shift Models** - Control box not working or cables out of adjustment **All Models** - Forward clutch pack improperly assembled, damaged forward clutch return spring, damaged clutch plates

REVERSE GEAR

SYMPTOM	CAUSE
1. Low fluid pressure	1. Low fluid level, dirty fluid screen, faulty fluid pump, fluid leak, faulty relief valve
2. Reverse clutch engages improperly	2. **Electric Shift Models** - Electric control box and/or shift motor not working properly **Manual Shift Models** - Control box not working or cables not adjusted properly **All Models** - Incorrect reverse band adjustment, control valve assembled incorrectly, fluid leak, damaged reverse band, improperly assembled reverse clutch band assembly, planetary gear failure

ALL GEARS

SYMPTOM	CAUSE
1. No fluid pressure	1. No fluid, fluid level low, broken pump, sheared pump drive key, faulty relief valve
2. Low fluid pressure	2. Low fluid level, dirty fluid screen, worn fluid pump, faulty relief valve
3. High fluid temperature	3. Fluid level low, dirty or plugged fluid cooler or fluid line, restricted water flow to fluid cooler
4. Does not shift	4. **Electric Shift Models** - Control box and/or shift motor not working properly, loose electrical connections, broken wires **Manual Shift Models** - Control box not working properly **All Models** - Control valve not assembled correctly

LEAKS

SYMPTOM	CAUSE
1. Fluid leaks at control valve	1. Fluid passage plugs leaking, loose bolts, damaged "O" rings, damaged gasket or foreign material on mating surface, porous control valve housing
2. Fluid leaks at pump	2. Damaged "O" rings, loose bolts, damaged oil seal, foreign material on mating surface, relief valve or fluid discharge passage plug leak, porous casting
3. Fluid leaks at output housing	3. Loose bolts, damage "O" ring, damaged oil seal, porous housing, foreign material on mating surfaces, fluid passage ball plug not properly seated
4. Fluid on exterior of transmission	4. Dipstick tube leaks, loose bolts, damaged gasket or foreign material on mating surfaces, damaged "O" rings, porous housing, damaged oil seal, fluid passage plugs leaking
5. Water in transmission fluid	5. Damaged fluid cooler

MISCELLANEOUS

SYMPTOM	CAUSE
1. Fluid foaming	1. High fluid level, air in fluid, dirty fluid screen
2. Gear noise in reverse	2. Nicks on gears, planetary gear failure
3. Pump noise	3. Low fluid level, dirty fluid screen
4. Flywheel drive plate noise or failure	4. Flywheel drive plate assembly damaged
5. High fluid pressure	5. Wrong fluid, cold fluid, faulty relief valve
6. Smoking	6. Low fluid level, transmission not shifting properly, reverse clutch lever not free, high rotational speed in reverse

POWER STEERING

POOR, ERRATIC, OR NO ASSIST

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Broken or out of adjustment
2. Low fluid level	
3. Air in system	3. Air leak in lines, pump, or air from installation. Refer to "Section 9" for bleeding procedure.
4. Leaking hoses	4. Refer to "Section 9" for bleeding procedure
5. Steering cable and/or steering helm	5. Cable or helm partially froze from corrosion or rust, cable over lubricated, improper cable installation
6. Binding in stern drive unit	6. Refer to appropriate "Stern Drive Service Manual"
7. Restriction in hydraulic hoses	7. Causes a loss of pressure
8. Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
9. Mounting bracket adjusting screw loose or mounting tube is loose	
10. Faulty pump	10. Flow control valve may be sticking
11. Worn piston ring or scored housing bore in cylinder	11. Causes loss of pressure
12. Leaking valve body or loose fitting spool	

NOISY PUMP

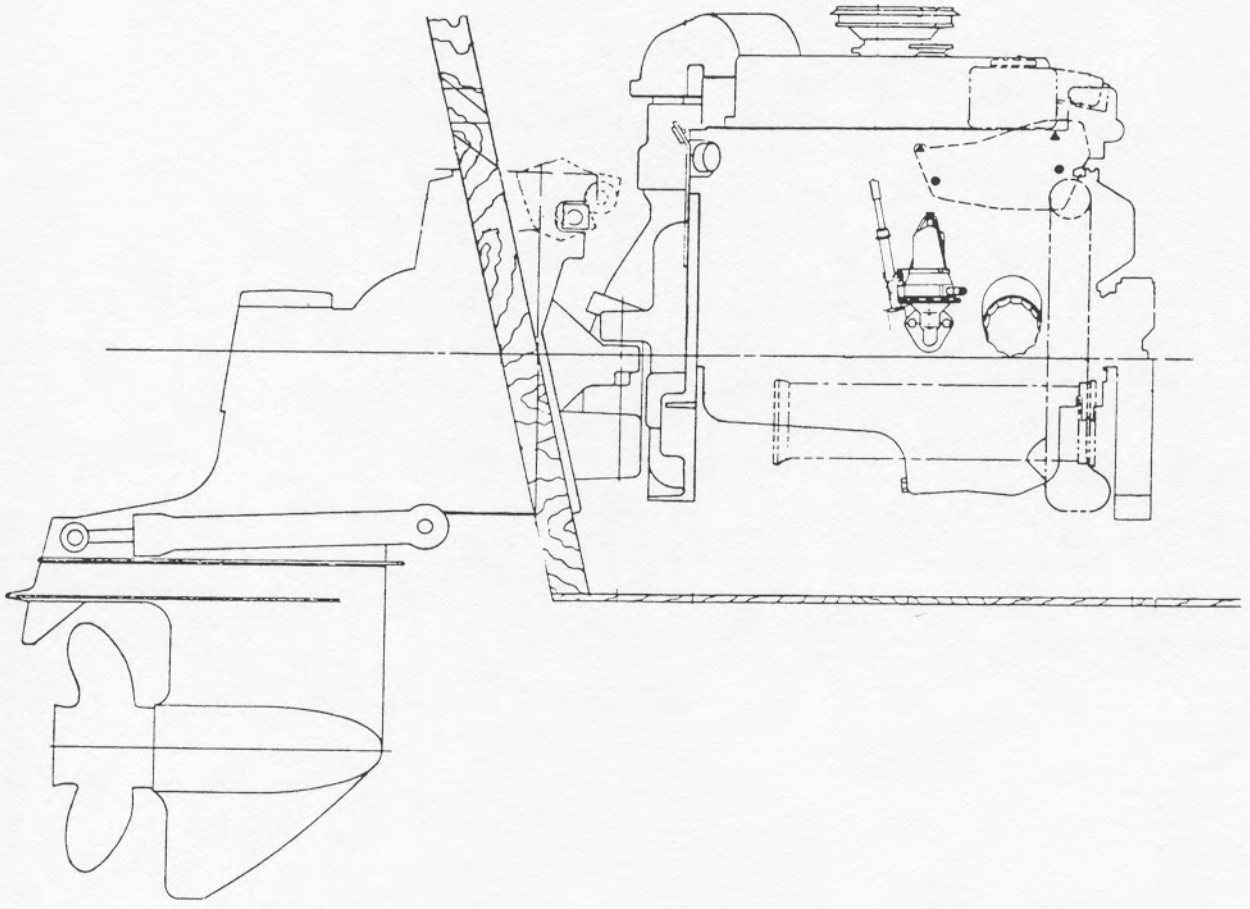
CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Check tension
2. Low fluid level	
3. Air in fluid	3. Air leak in lines, pump, or air from installation. Refer to "Section 9" for bleeding procedure.
4. Faulty pump	4. Use stethoscope to listen for noise in the pump
5. Restricted fluid passages	5. Kinks or debris in hoses or debris in passages
6. Stop nut adjusted improperly	6. Refer to appropriate "Stern Drive Service Manual"
7. Steering cables installed that do not meet BIA standards	7. Refer to appropriate "Stern Drive Service Manual"

FLUID LEAKS

CAUSE	SPECIAL INFORMATION
1. Loose hose connections	1. Refer to "Section 9" for bleeding procedure
2. Damaged hose	
3. Fluid leaking from top of pump	3. System overfilled, fluid contains water, fluid has air in it
4. Cylinder piston rod seal	
5. Faulty seals in valve	
6. Faulty seals or "O" rings in pump	
7. Cracked or porous metal parts	

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART A - MCM 120-140-165



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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Attaching/Adjusting Throttle Cable	2A-7

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Battery Cables	Securely
Drive Unit Shift Cable Brass Barrel Cable End Guide	 Spread Cotter Pin (Note 1)
Front Engine Mount	Securely
Hose Clamps	Securely
Rear Engine Mounts	35-40 (47-54)
Remote Control Shift Cable Brass Barrel Cable End Guide	 Securely (Note 1)
Remote Control Throttle Cable Brass Barrel Cable End Guide	 Securely (Note 1)

NOTE 1: Tight, then back nut off 1/2 turn.

TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Multi-Lube

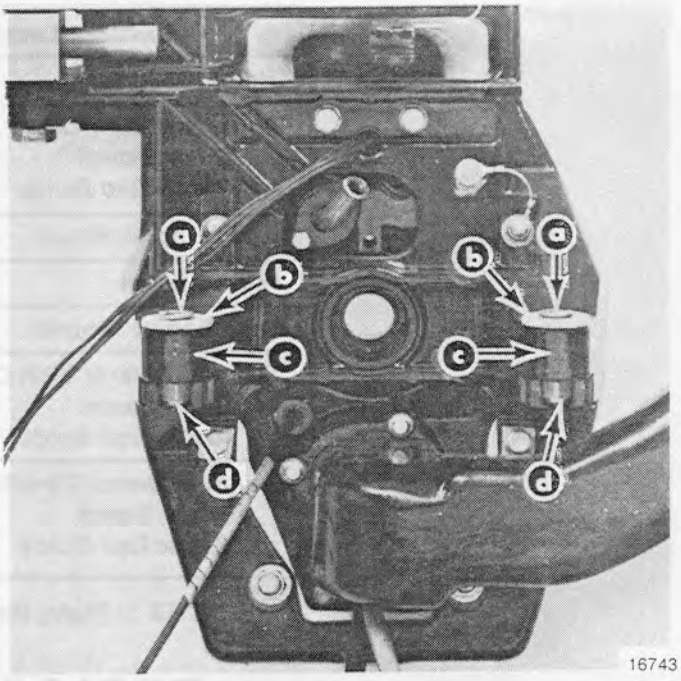
REMOVAL

NOTICE
Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual."

1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. **MCM 120/140/165:** Disconnect shift cutout switch wires from terminal block (located on shift plate).
   MCM 120/120R/140/140R/165: Disconnect trim position sender wires from terminal block (located on engine harness bracket).
4. Remove red and black Power Trim pump motor wires from engine (some models).
5. Disconnect water inlet hose and exhaust elbow bellows.
6. **MCM 120/140/165:** Remove drive unit shift cable from "J" clamp (located on flywheel housing).
   MCM 120R/140R: Remove both shift cables from shift plate assembly (located on exhaust manifold).
7. Disconnect any grounding wire or accessories that are connected to the engine.
8. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
9. Carefully remove engine.

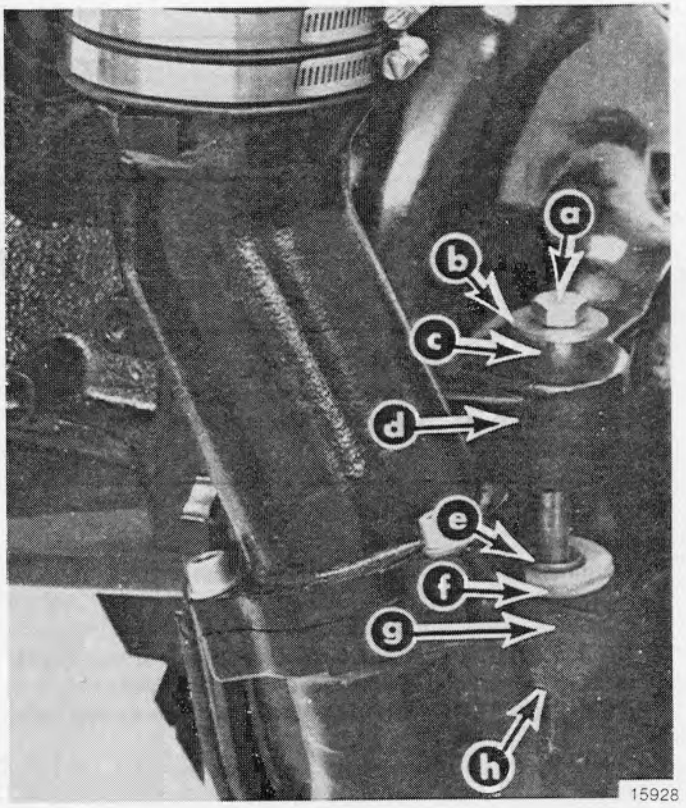
INSTALLATION

1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Lubricate engine coupling splines with 2-4-C Multi-Lube.
3. Place large fiber washer on top on inner transom plate engine mounting brackets and double wound lockwasher inside fiber washer. (Figure 1)
4. Place engine over transom plate mounting brackets. Place hose clamps over rubber exhaust elbow bellows and position bellows over exhaust elbow outlet.
5. Place steel washers and spacers on mounting bolts and insert bolts down thru rear engine mounts, washers and mounting brackets. Thread elastic stop nuts on bolts. Torque to specification. (Figure 2)



a - Double Wound Lockwasher
b - Fiber Washer
c - Mounting Brackets
d - Elastic Stop Nuts (Engine Mounting Bolts)

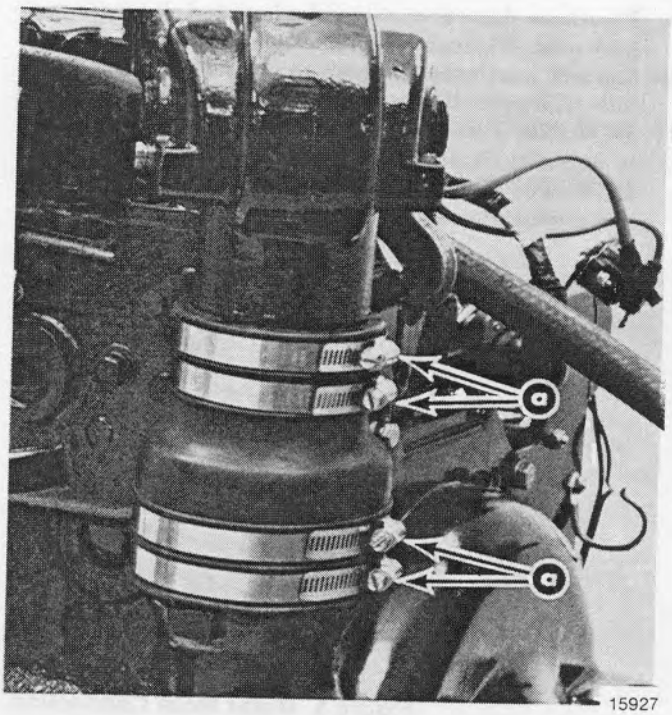
Figure 1. Transom Plate



a - Rear Engine Mounting Bolt
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer
g - Mounting Bracket
h - Elastic Stop Nut (Hidden)

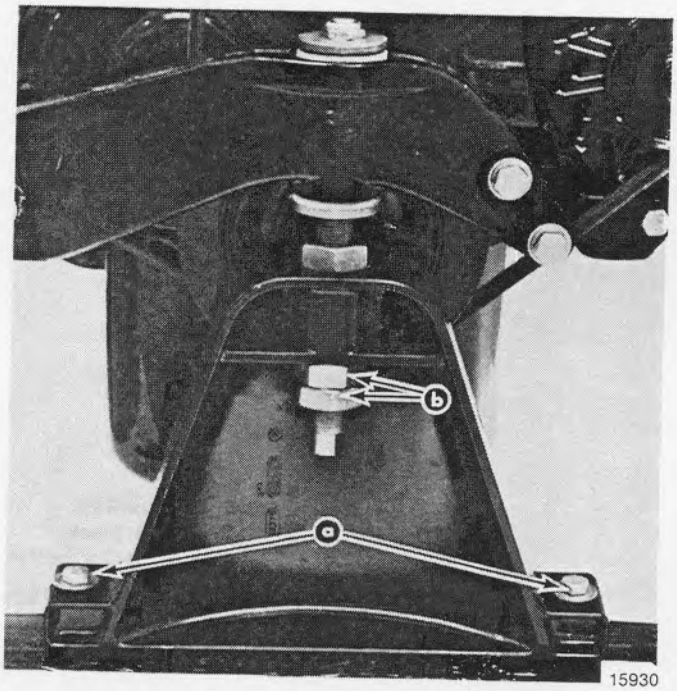
Figure 2. Securing Rear Engine Mounts

6. Tighten exhaust bellow clamps securely. (Figure 3)
7. Secure front engine mount to boat. (Figure 4)
8. Check engine alignment. Refer to "Alignment". After correct alignment is attained, tighten lower nuts securely. (Figure 4)



a - Clamps

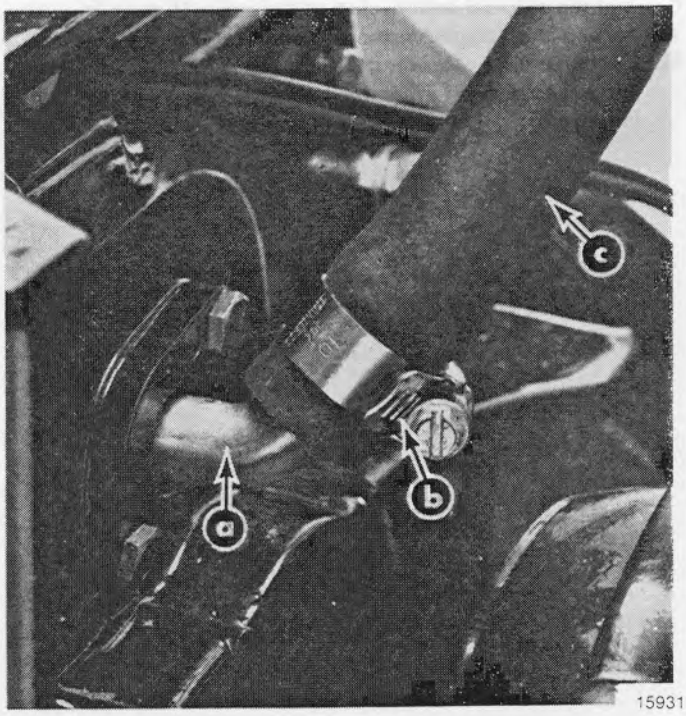
Figure 3. Exhaust Bellows



a - Mounting Bolt Holes
b - Lower Nuts

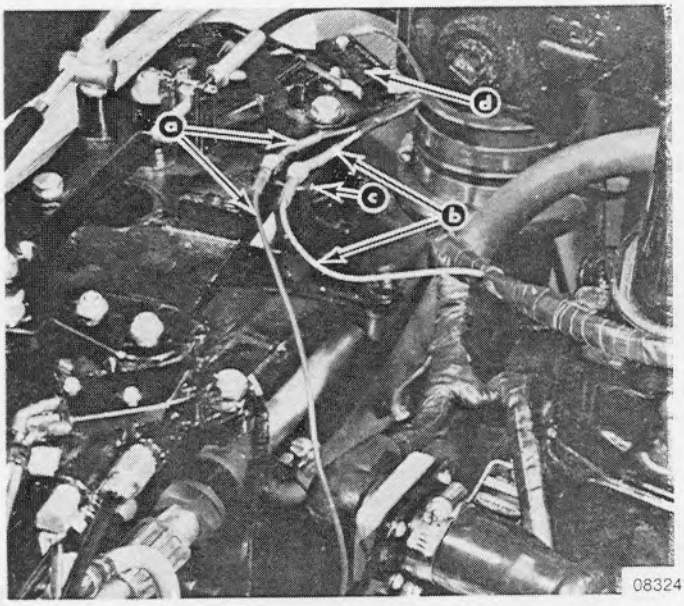
Figure 4. Securing Front Engine Mount

9. Place hose clamp over water inlet hose and place hose over inlet tube. (Figure 5) Tighten clamp securely.
10. Connect instrument harness to engine harness. Secure with clamp and tighten clamp.
11. **MCM 120/140/165:** Connect shift cutout switch wires as shown in Figure 6.
    MCM 120/120R/140/140R/165: Connect trim position sender wires as shown in Figure 7.



a - Water Tube
b - Hose Clamp
c - Water Hose

Figure 5. Water Hose Connection

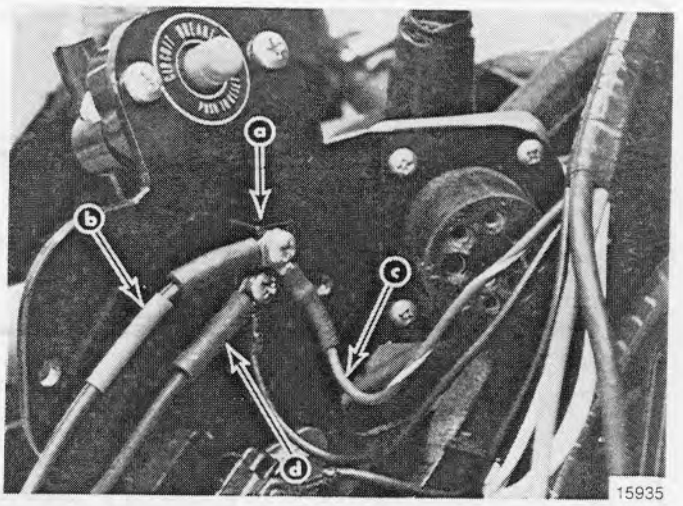


a - Black
b - Brown or Gray
c - Terminal Block
d - Shift Cut-Out Switch

Figure 6. MCM 120/140/165

a - Terminal Block
b - Brown or Purple Sleeve — To Insulated Terminal
c - Brown/White Wire — To Insulated Terminal
d - Without Sleeve - To Terminal Block Mounting Screw

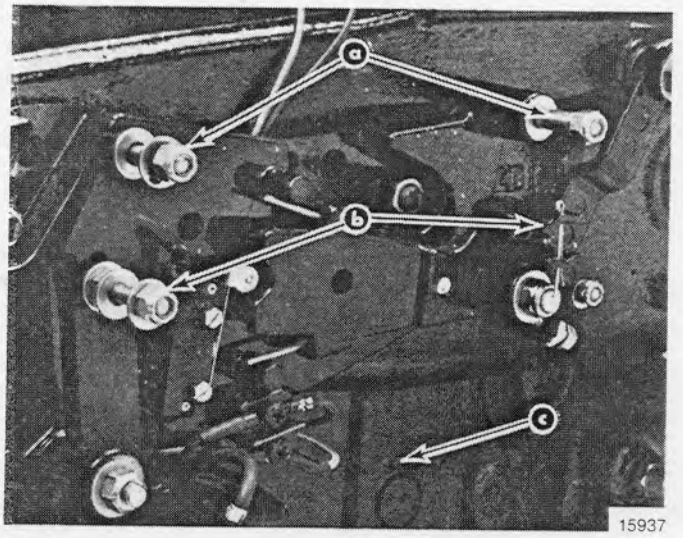
Figure 7. MCM 120/120R/140/140R/165



12. Connect fuel line. Check for fuel leaks.
13. **MCM 120/140/165:** Place drive unit shift cable in "J" clamp (located on flywheel housing) and bend clamp closed.
    MCM 120R/140R: Connect drive unit and remote control shift cables as shown in Figure 8.

    IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".

14. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
15. Connect red and black trim pump wires (some models).
16. Connect any ground wires or accessories that may have been disconnected.
17. Connect battery cables to battery.



a - Remote Control Shift Cable Attaching Points
b - Drive Unit Shift Cable Attaching Points
c - Exhaust Manifold

Figure 8. MCM 120R/140R

ALIGNMENT

To ensure more engine coupler engagement during the alignment of MCM 120R and 140R model engines, modify the alignment tool as shown in Figure 1. This modification will improve engine coupler engagement on the other model engines also.

IMPORTANT: DO NOT remove more than .560" from gimbal bearing area of alignment tool. This .560" dimension ensures that the gimbal bearing will straddle the existing "under cut" in alignment tool.

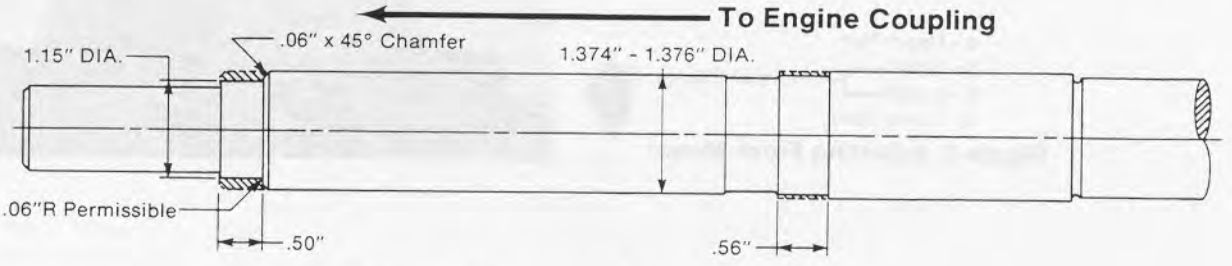


Figure 1. Alignment Tool Modification

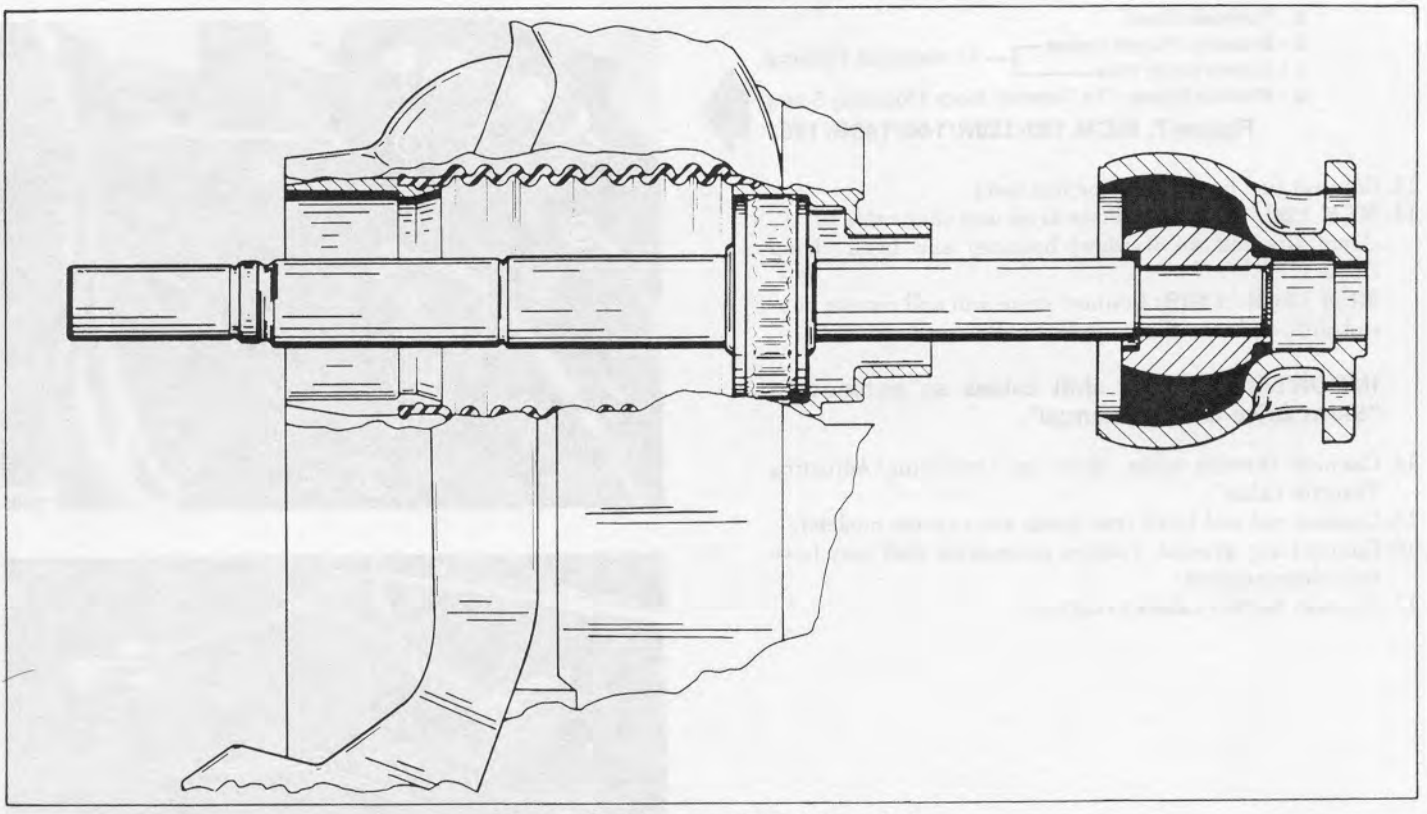
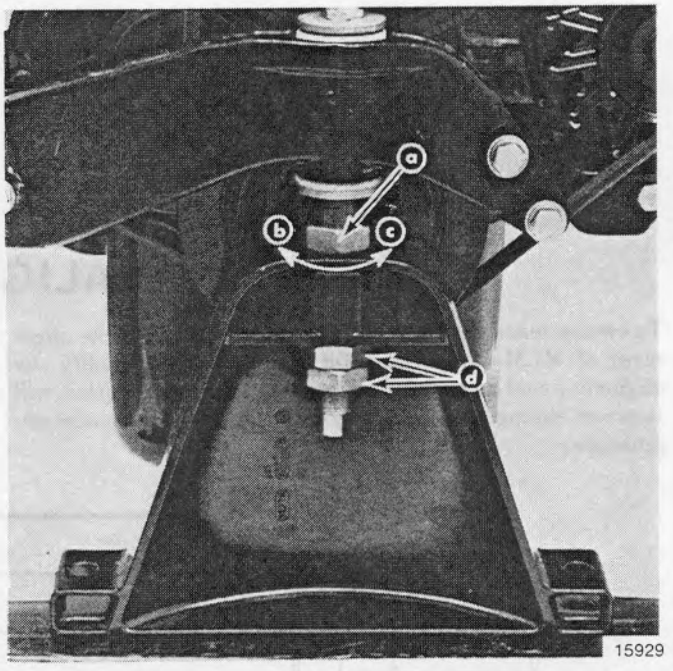


Figure 2. Alignment Tool Inserted

1. Using Alignment Tool (91-57797A3), insert end of shaft (which does not have threaded hole) thru gimbal bearing. Move gimbal bearing, as required, to insert shaft into engine coupling. (Figure 2)
2. If shaft enters coupling freely with no pressure, alignment is correct. If not, proceed as follows:
   a. Loosen front mount adjusting nuts and thread either way to raise or lower front of engine until alignment is correct. (Figure 3)
   b. After correct alignment shaft fit is attained, tighten lower nuts securely. Recheck alignment shaft fit.

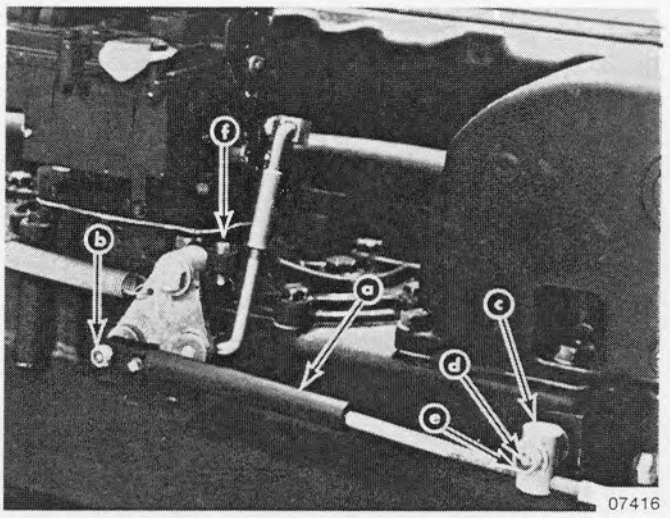


a - Upper Nut
b - Raise
c - Lower
Front of Engine
d - Lower Nuts

Figure 3. Adjusting Front Mount

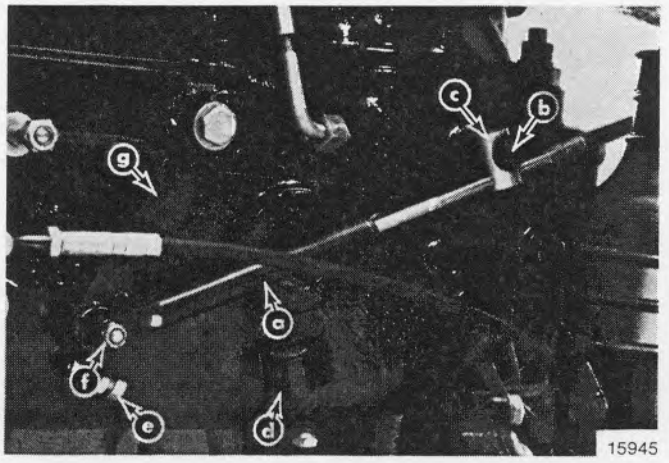
ATTACHING/ADJUSTING THROTTLE CABLE

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown in Figure 1 or 2.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud or threaded hole in manifold. Fasten barrel as shown in Figure 1 or 2.
4. Check that throttle valves are fully open when remote control is in full throttle position. With throttle valves fully open, check wide open throttle stop screw. Turn screw until it just touches stop, then turn ¼ turn more. Tighten locking nut securely to prevent stop screw from turning.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop.



a - Cable End Guide
b - Washer and Nut (DO NOT Over-Tighten)
c - Brass Barrel
d - Stud
e - Washer and Nut (Tighten Securely)
f - W.O.T. Stop Screw

Figure 1. MCM 120/140/165

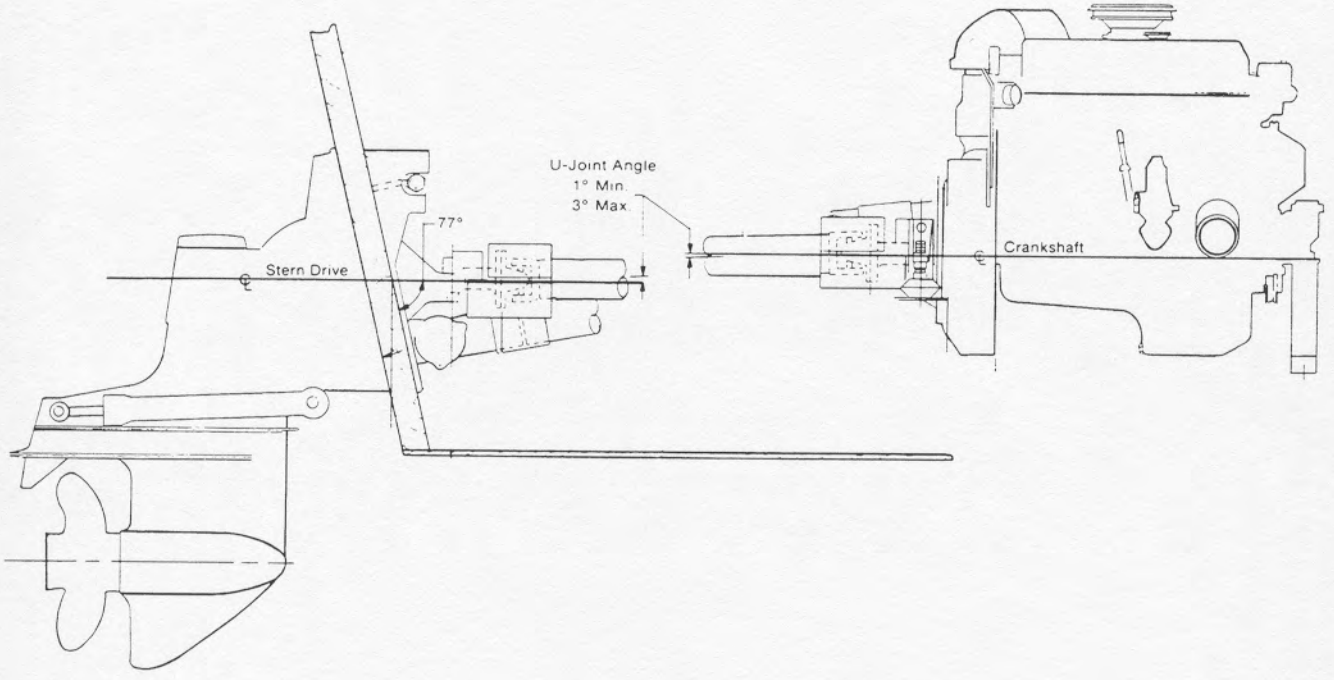


a - Cable End Guide
b - Anchor Screw (Tighten Securely)
c - Brass Barrel (Cable Must Be Positioned As Shown)
d - W.O.T. Throttle Stop
e - W.O.T. Throttle Stop Screw
f - Washer and Nut (DO NOT Over-Tighten)

Figure 2. MCM 120R/140R

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART B - MCM 120R-140R DRIVE SHAFT EXTENSION MODELS



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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Battery Cables	Securely
Bearing Support to Inner Transom Plate	50 (68)
Drive Shaft	50 (68)
Drive Shaft Shield	30 (41)
Extension Housing to Flywheel Housing	30 (41)
Flywheel Housing	30 (41)
Front and Rear Engine Mounts	Securely
Hose Clamps	Securely
Rear Engine Mount Bracket	50 (68)
Remote Control Throttle Cable	
Brass Barrel	Securely
Cable End Guide	(Note 1)

NOTE 1: Tight, then back nut off 1/2 turn.

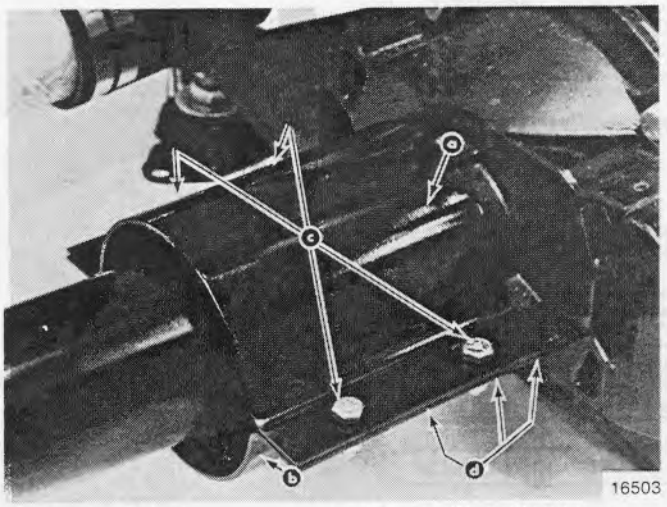
TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Multi-Lube
9-GT-3984	Sears Craftsman Universal Protractor

REMOVAL

NOTICE
Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual."

1. Disconnect battery cables from battery and remove instrument harness plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Slide sleeves back on black and white/green wires and disconnect engine harness wires from shift cut-out switch harness.
4. Disconnect brown/white wire from terminal block (on engine harness plug bracket).
5. Disconnect water inlet hose (from thermostat housing).
6. Disconnect exhaust pipe from exhaust hose.
7. Remove top shield and then bottom shield. (Figure 1)



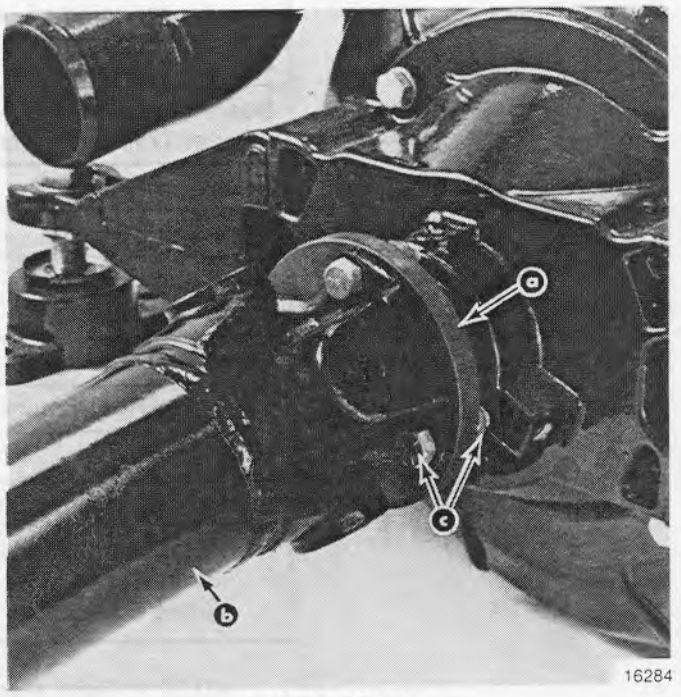
a - Top Shield
b - Bottom Shield
c - 4 Screws/Nuts (2 Hidden)
d - 3 Screws (Hidden)

Figure 1. Top/Bottom Shield Removal

8. Disconnect drive shaft from output flange. (Figure 2)
9. Disconnect any grounding wire or accessories that are connected to the engine.

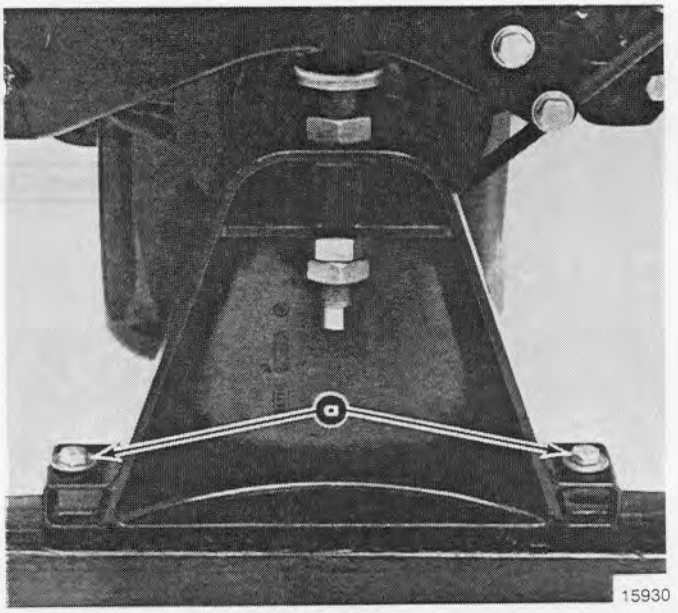
IMPORTANT: To avoid the need for a complete realignment (after engine repair), DO NOT move front or rear mounts. Remove mounting bolts as shown in Figures 3 and 4.

10. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts as shown in Figures 3 and 4.
11. Carefully remove engine.



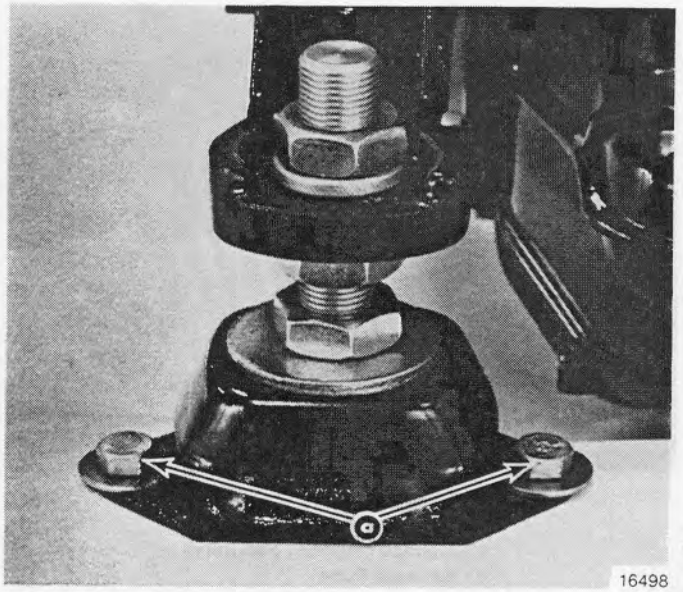
a - Output Flange
b - Drive Shaft
c - Screw/Nut (4)

Figure 2. Disconnecting Drive Shaft



a - Mounting Bolts

Figure 3. Front Mount



a - Mounting Bolts

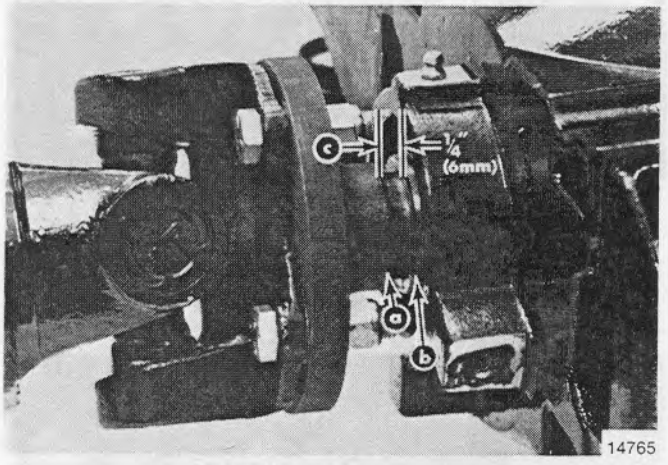
Figure 4. Rear Mounts

INSTALLATION

NOTICE
If engine mounts or drive shaft have been changed, refer to "Alignment" before starting installation.

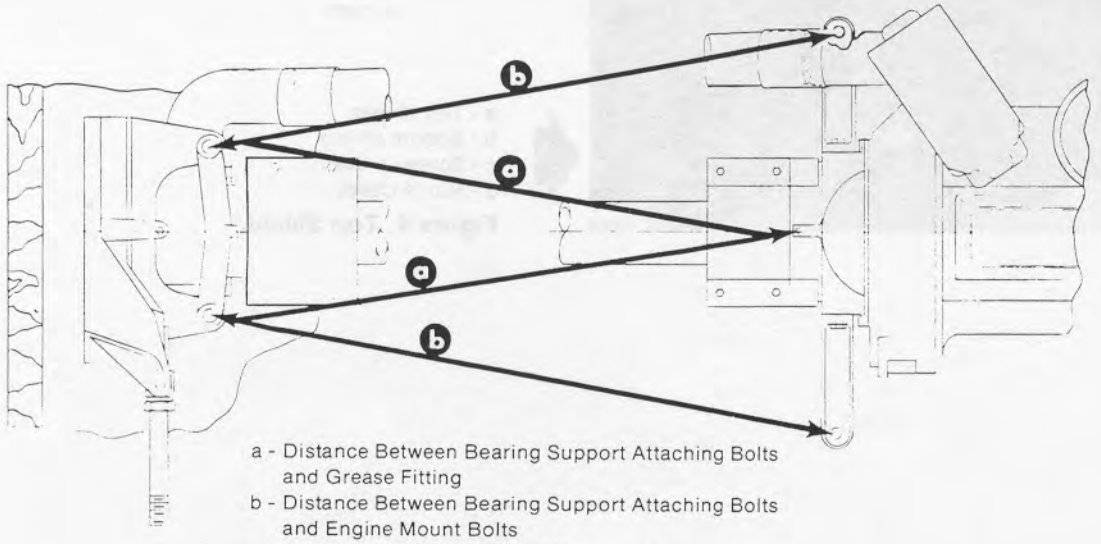
1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Set engine on stringers.
3. Connect drive shaft to output flange. Torque screws and nuts to specifications.
4. Relieve hoist tension from engine; then slide engine fore or aft as needed to obtain a ¼" (6mm) between flange shoulder and extension shaft housing bearing. (Figure 1)

IMPORTANT: Failure to properly position output shaft flange (as described following) may result in bearing damage.



a - Flange Shoulder
b - Bearing c - 1/4" (6mm)

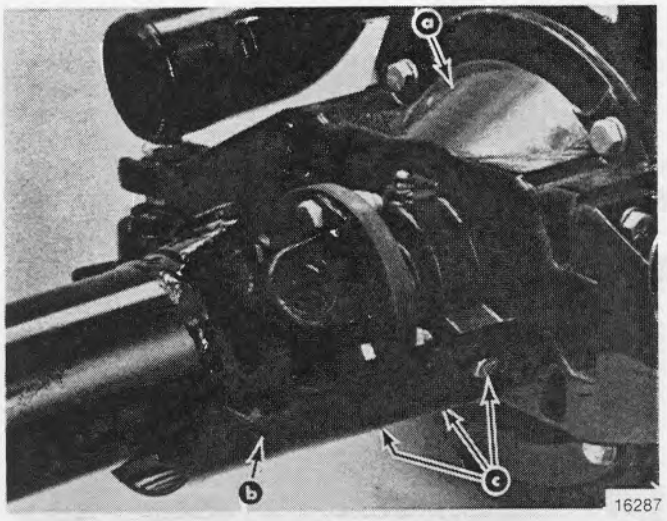
Figure 1. Distance Between Output Shaft Shoulder and Bearing



a - Distance Between Bearing Support Attaching Bolts and Grease Fitting
b - Distance Between Bearing Support Attaching Bolts and Engine Mount Bolts

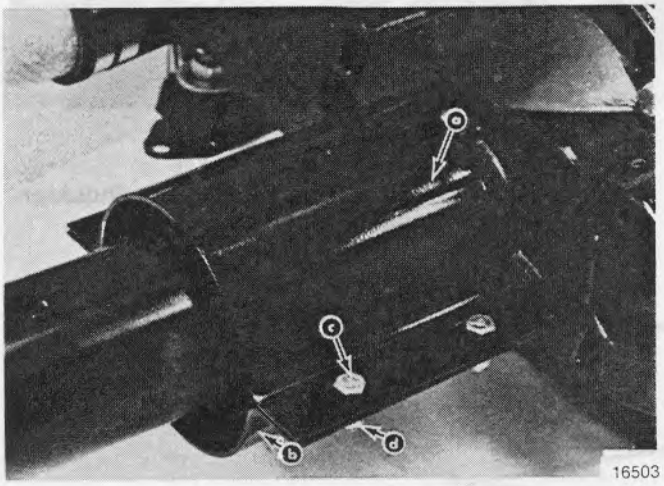
Figure 2. Engine Alignment

5. Measure distance between the center of the bearing support attaching bolts and rear engine mount adjusting bolt, as shown in Figure 2. These distances MUST BE equal. If not, slide front of engine to one side or the other until distances are equal.
6. After engine has been aligned correctly, fasten front and rear engine mounts to stringers.
7. Install top and bottom shield. Torque screws to specifications. (Figures 3 and 4)
8. Connect exhaust pipe to exhaust hose. (Figure 5)
9. Connect water inlet hose to thermostat housing.
10. Reconnect shift cut-out switch harness to engine harness. (Figure 6)



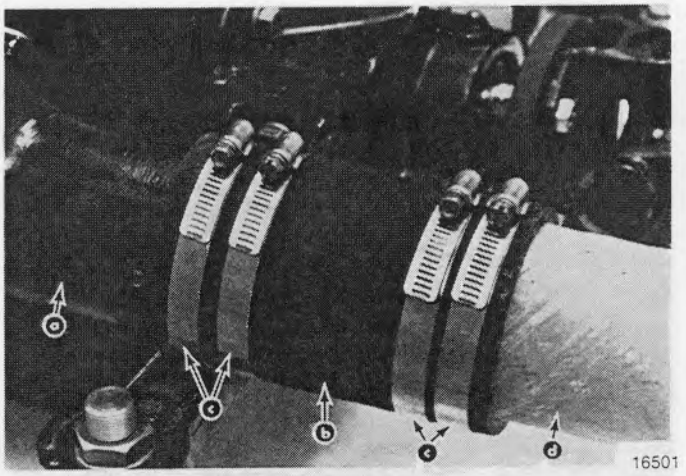
a - Shaft Housing
b - Bottom Shield
c - Screws (Threads of screws are coated with Loctite)

Figure 3. Bottom Shield



a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used)

Figure 4. Top Shield



a - Exhaust Pipe
b - Exhaust Hose
c - Clamps (Tighten Securely)
d - Exhaust Tube

Figure 5. Exhaust Connection

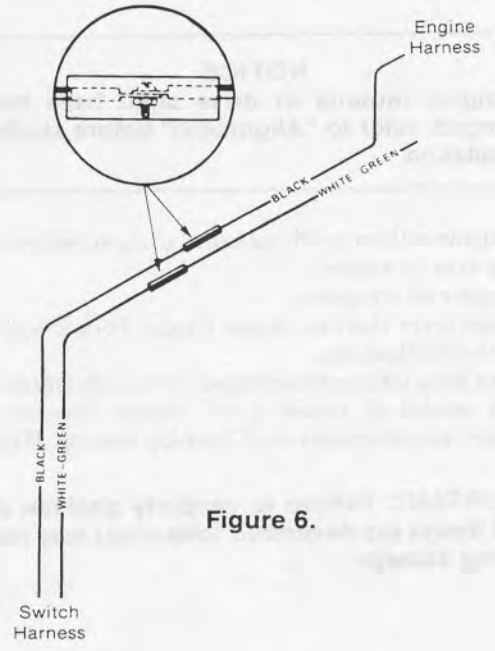
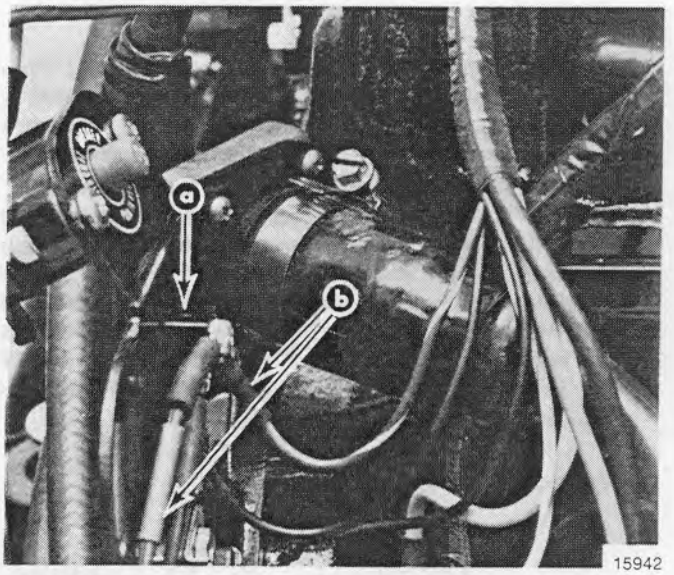


Figure 6.

11. Connect instrument harness to engine harness. Tighten clamp.
12. Connect trim position sender brown/white wire as shown in Figure 7.
13. Connect fuel line. Check for leaks.
14. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
15. Connect any grounding wires or accessories that may have been disconnected.
16. Connect battery cables to battery.

IMPORTANT: If stern drive unit was removed, refer to step 14 in "Alignment".



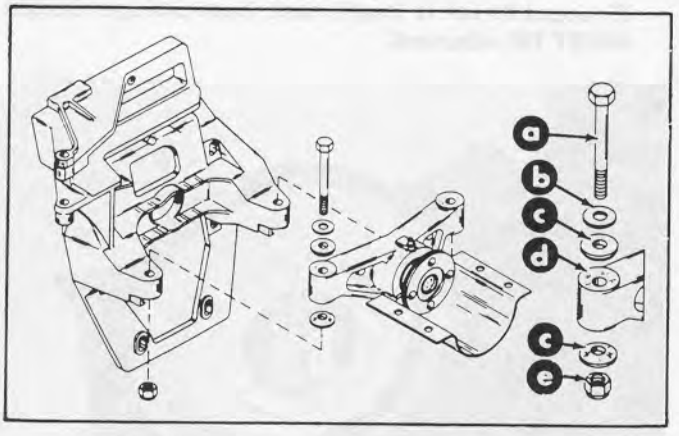
a - Terminal Block
b - Brown/White Wires

Figure 7. Sender Connection

ALIGNMENT

BEARING SUPPORT INSTALLATION

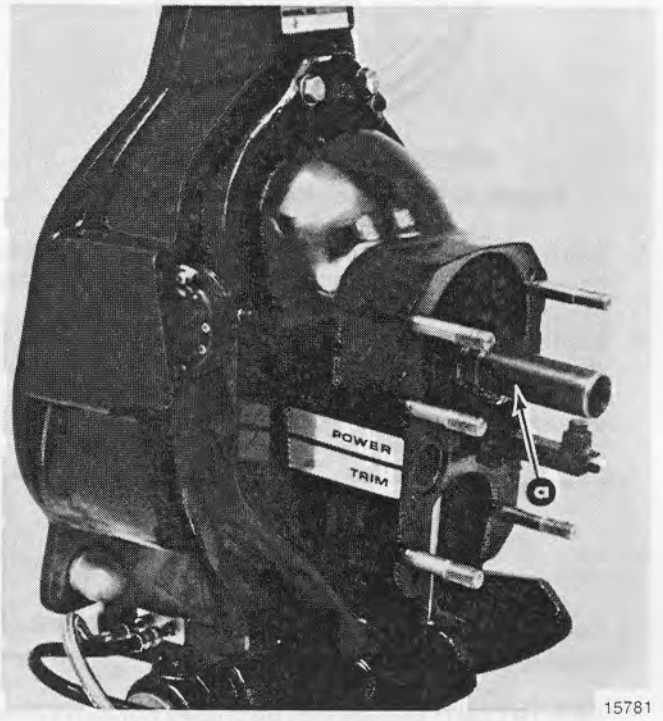
The following procedure MUST BE used when installing bearing support on MCM 120R/140R Models:



a - Bolt (2)
b - Flat Washer (2)
c - Spherical Washer (4) (Install with Rounded Side Toward Bearing Support)
d - Bearing Support
e - Nut (2)

Figure 1. Bearing Support Attaching Parts

1. Install bearing support, as shown in Figure 1. DO NOT tighten bolts.
2. Insert solid end of Alignment Tool (91-57797A3) thru bearing in gimbal housing and into input shaft splines. (Figure 2)
3. Tighten bearing support bolts until snug [5-10 lbs. ft. (7-13 N.m)]. Strike the head of both bolts with a ball peen hammer, then torque bolts to specifications.



a - Alignment Shaft

Figure 2. Alignment Tool Installed

IMPORTANT: Bearing support attaching bolts MUST BE struck with a hammer to properly seat spherical washers. If procedure is not followed, difficulty in installing stern drive unit may result and subsequent damage to bearings may occur from misalignment.

ALIGNMENT

IMPORTANT: A Sears Craftsman Universal Protractor (stock number 9-GT-3984) or equivalent is required for measuring the angles in the following steps. Protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0° and the 90° marks will be used. It should be kept in mind that these are reference marks only and the actual numbers should be ignored. (Figure 3) It is only necessary to note the number of degrees and to which side (left or right) of the reference marks the indicator needle rests. PROTRACTOR MUST BE VIEWED FROM THE SAME SIDE OF POWER PACKAGE THROUGHOUT ALIGNMENT.

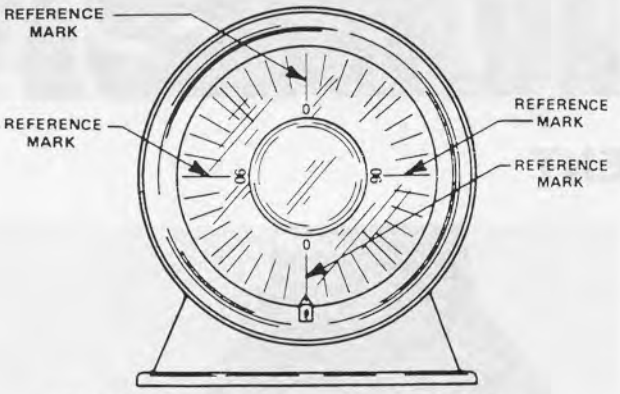


Figure 3. Protractor Reference Marks

1. Insert solid end of alignment tool thru bearing in gimbal housing and into bearing support input shaft splines. (Figure 2)
2. Position base of protractor against input shaft flange, as shown in Figure 4. NOTE and RECORD the number of degrees and to which side of the reference mark the indicator needle has moved in the chart following.

READING from STEP 2
_____ degrees to the
_____ side of Reference mark.

IMPORTANT: Be sure that boat does not move once reading has been taken from input shaft flange, as this reading establishes reference point for aligning drive shaft and engine following.

3. Lift engine into boat, using an overhead hoist and a chain (attached to lifting eyes on engine).

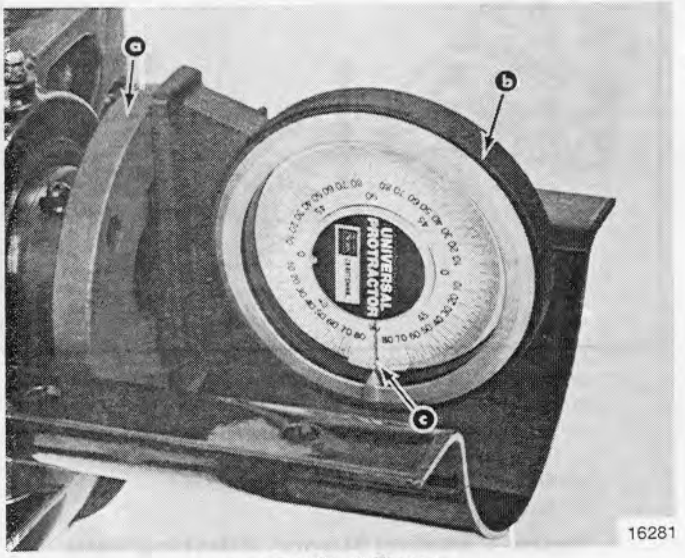
⚠CAUTION

When attaching drive shaft in next step. BE SURE that the pilots on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges MUST BE flush to each other prior to tightening screws, or screws may come loose during operation.

4. Attach drive shaft to input shaft flange and output shaft flange, as shown in Figures 5 and 6.
5. Position base of protractor on drive shaft (Figure 7); then, adjust engine mounts so that indicator needle is 1° to 3° on either side of reading taken in Step 2. Record this reading in the following chart for later use.

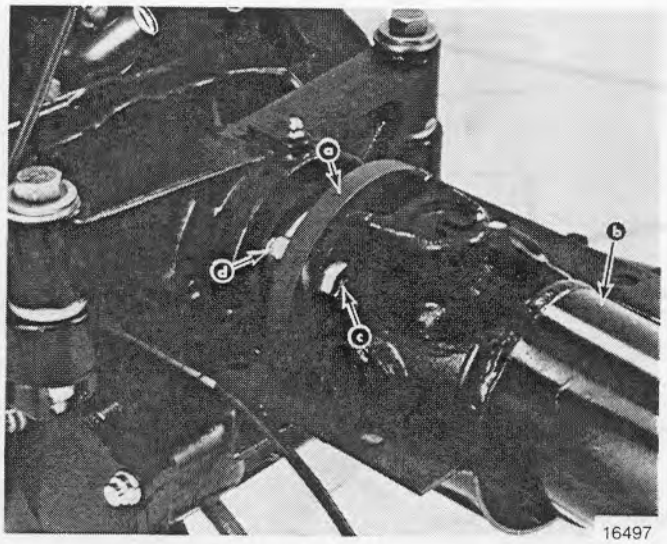
READING from STEP 5
_____ degrees to the
_____ side of Reference mark.

IMPORTANT: A minimum of ¼" (6mm) up-and-down engine mount adjustment must exist after engine has been properly aligned. This is necessary to allow for realignment of the engine in the future. If mount travel is insufficient, boat stringer height MUST BE adjusted.



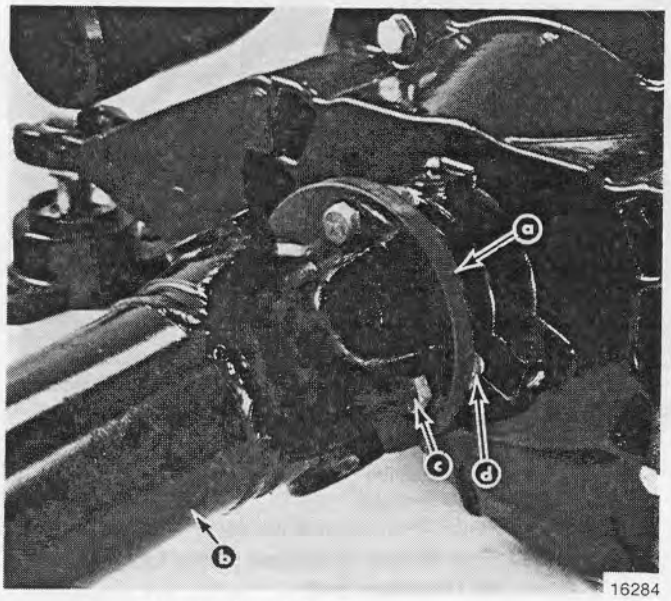
a - Input Shaft Flange
b - Protractor
c - Indicator Needle

Figure 4. Measuring Angle of Input Shaft Flange



a - Input Shaft Flange
b - Drive Shaft
c - Screw (4 Used) (Torque to Specifications)
d - Nut (4 Used)

Figure 5. Drive Shaft Attached to Input Shaft Flange

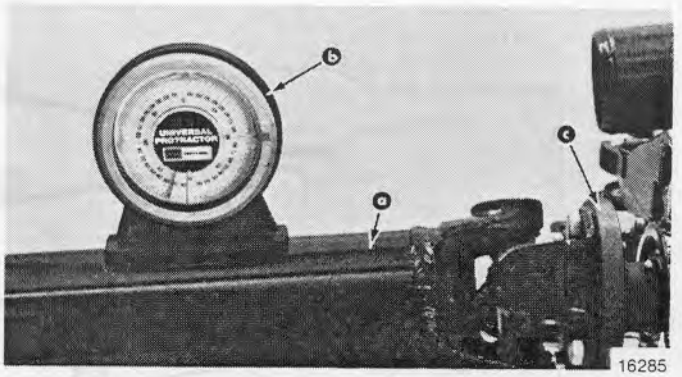


a - Output Shaft Flange
b - Drive Shaft
c - Screw (4 Used) (Torque to Specifications)
d - Nut (4 Used)

Figure 6. Drive Shaft Attached to Output Shaft Flange

a - Flange Shoulder
b - Bearing
c - 1/4" (6mm)

Figure 8. Distance Between Output Shaft Shoulder and Bearing



a - Drive Shaft
b - Protractor
c - Output Shaft Flange

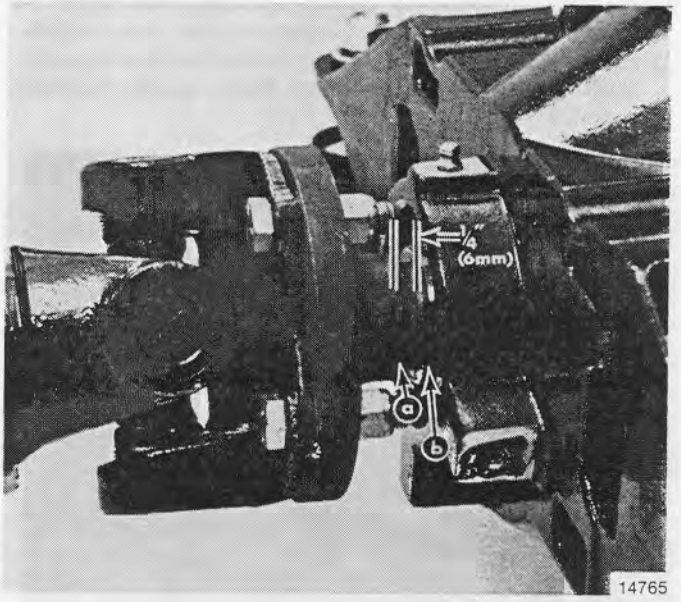
Figure 7. Measuring Drive Shaft Angle

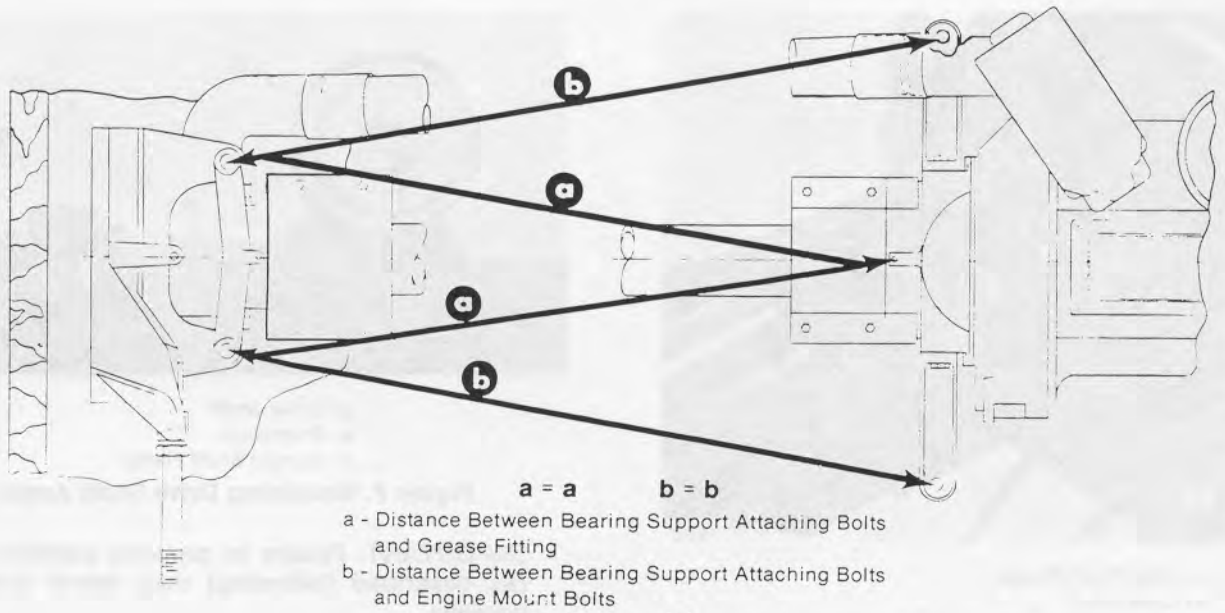
IMPORTANT: Failure to properly position engine (as described following) may result in bearing damage.

6. Relieve hoist tension from engine, then slide engine fore or aft as needed to obtain a ¼" (6mm) between flange shoulder and extension shaft housing bearing, as shown in Figure 8.

⚠CAUTION

Engine MUST BE aligned correctly to achieve proper engine operation and to prevent damage to drive shaft. If drive shaft is run at an incorrect angle, damage to universal joint bearings may result.

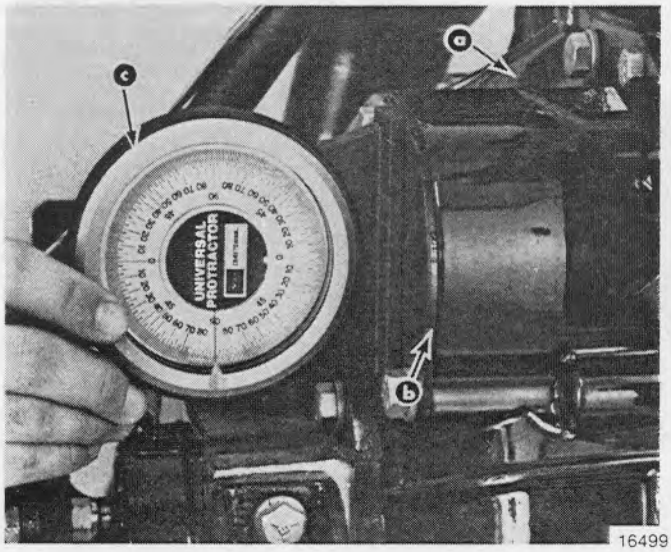




a - Distance Between Bearing Support Attaching Bolts and Grease Fitting
b - Distance Between Bearing Support Attaching Bolts and Engine Mount Bolts

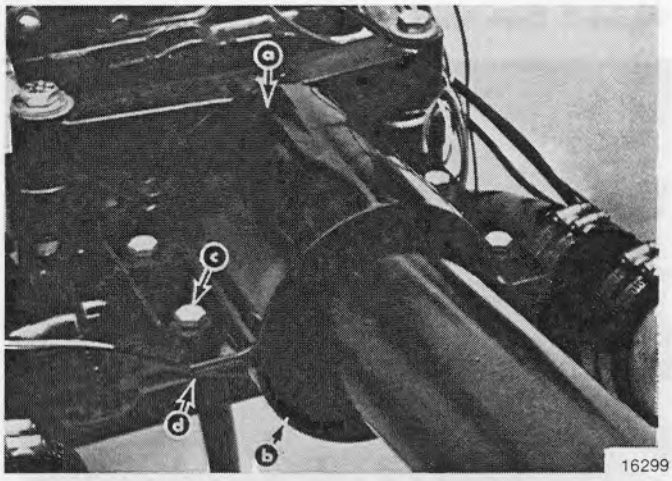
Figure 9. Engine Alignment

7. Position engine for correct engine and drive shaft lateral alignment as follows:
   a. The distance between the center of the bearing support attaching bolts (on inner transom plate) and grease fitting on shaft extension housing (Figure 9) MUST BE equal. If not, slide aft end of engine to one side or the other until distances are equal.
   b. Measure distance between the center of the bearing support attaching bolts and rear engine mount adjusting bolt, as shown in Figure 9. These distances also, MUST BE equal. If not, slide front of engine to one side or the other until distances are equal.
8. After engine has been aligned correctly, fasten front and rear engine mounts to stringers.
9. Position protractor on starter housing cover plate, as shown in Figure 10. Now, raise or lower front engine mount adjusting nuts as required so that protractor needle reads exactly the same number of degrees as that recorded in Step 2.



a - Flywheel Housing
b - Starter Housing Cover Plate
c - Protractor

Figure 10. Protractor Positioned Correctly on Starter Housing Cover Plate

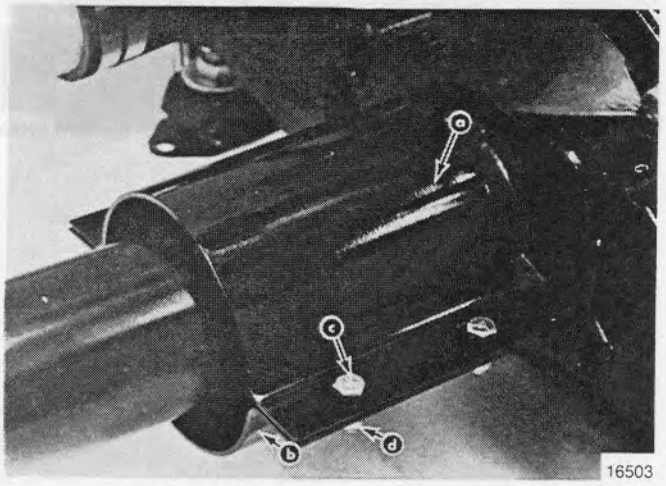


a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used) (Torque to Specifications)

Figure 11. Top Shield Attached to Bottom Shield at Transom End

10. Position protractor on drive shaft (as shown in Figure 7) and recheck angle. Angle should be the same as that recorded in Step 5. If not, raise or lower all engine mount adjusting nuts an equal amount until correct angle is reached.
11. Tighten ALL engine mount locking nuts securely.
12. Remove alignment shaft from gimbal housing.
13. Install drive shaft shields. (Figures 11 and 12)

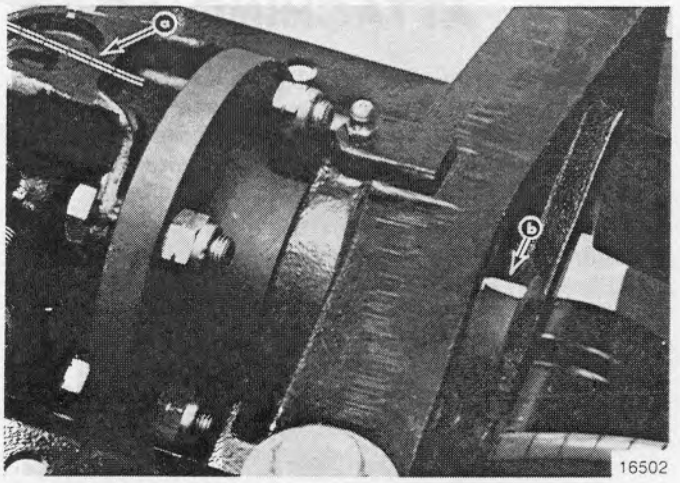
14. Install stern drive unit. Stern drive unit installation procedure is the same as that for the standard models, with the following exceptions:
    - No alignment is necessary, other than to align gimbal bearing with bearing support input shaft, Step 2 and 3.
    - Stern drive universal joints MUST BE aligned with drive shaft universal joints, as shown in Figures 13 and 14. Place a reference mark (white paint) on shafts to correspond with universal joint centerlines. After installing stern drive, check to ensure that these marks are in alignment.



16503

a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used) (Torque to Specifications)

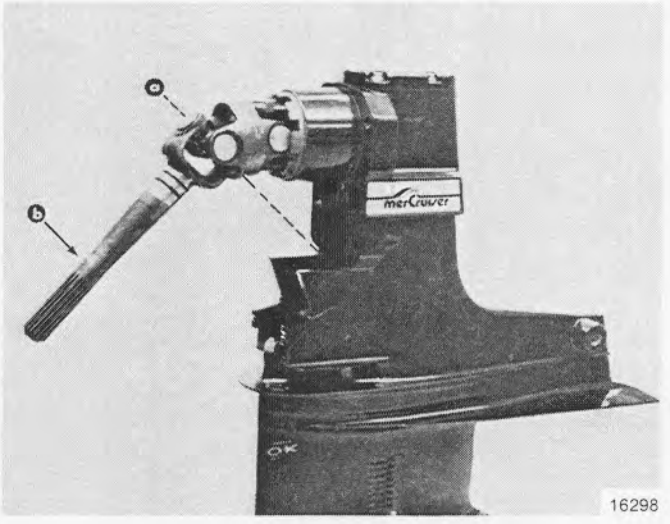
Figure 12. Top Shield Attached to Bottom Shield at Engine End



16502

a - Imaginary Centerline Running Thru This Universal Joint Bearing Must Be Vertical
b - Place a Reference Mark Here To Correspond with "a"

Figure 13. Aligning Drive Shaft Universal Joint



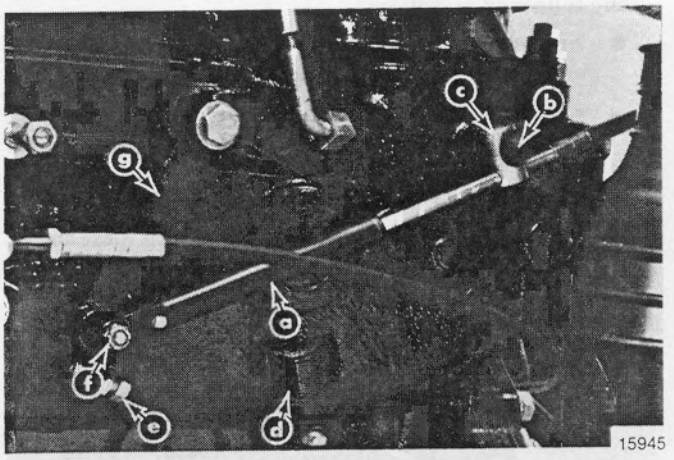
16298

a - Imaginary Centerline Running Thru This Universal Joint Bearing Must Be Vertical (Once Drive Unit Is Installed)
b - Place a Reference Mark Here To Correspond with "a"

Figure 14. Aligning Stern Drive Unit Universal Joints

ATTACHING/ADJUSTING THROTTLE CABLE

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown in Figure 1.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with threaded hole in manifold. Fasten barrel as shown in Figure 1.
4. Check that throttle valves are fully open when remote control is in full throttle position. With throttle valves fully open, check wide open throttle stop screw. Turn screw until it just touches stop, then turn ¼ turn more. Tighten set nut securely to prevent stop screw from turning. (Figure 1)
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop.

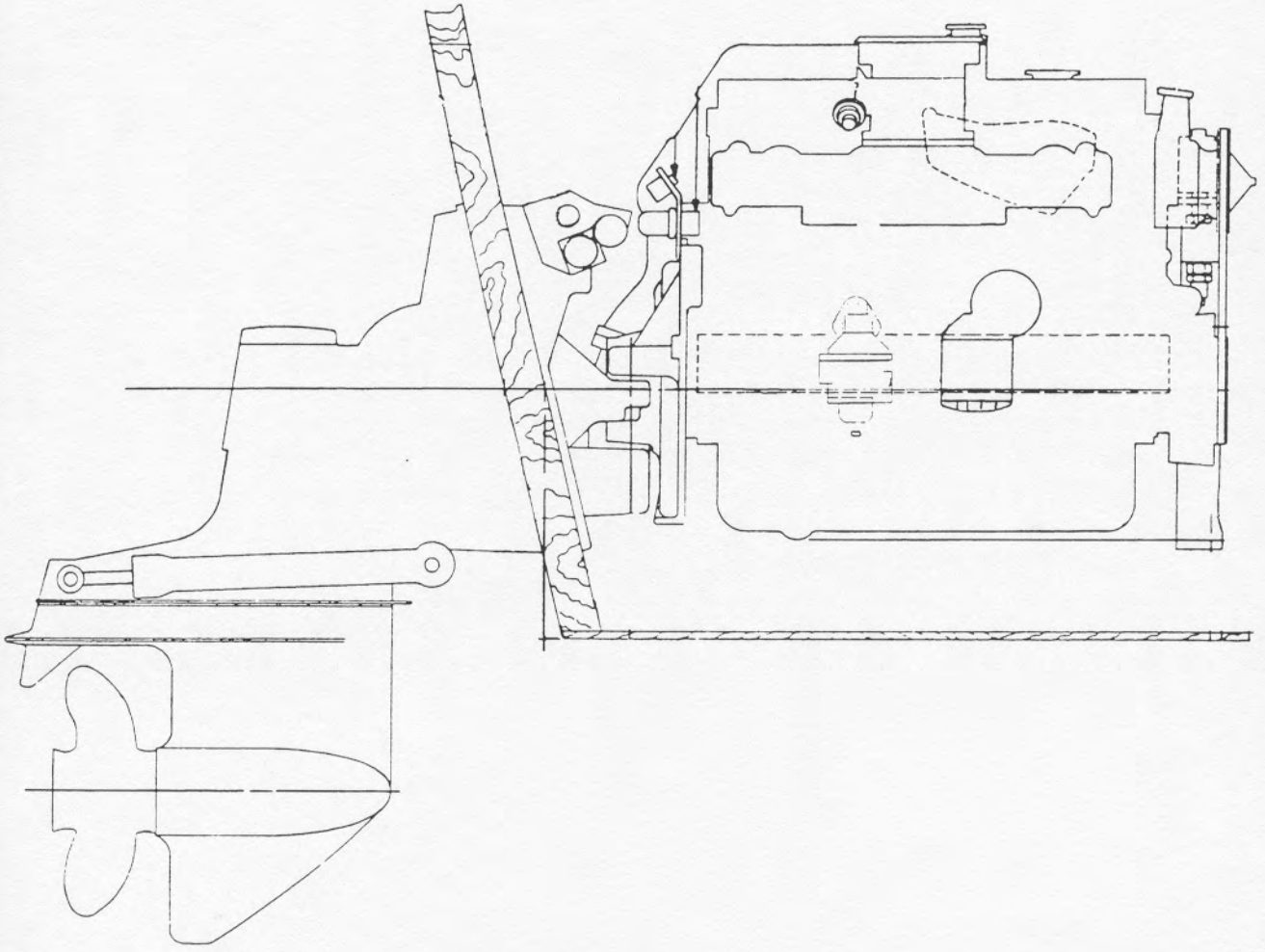


a - Cable End Guide
b - Anchor Screw (Tighten Securely)
c - Brass Barrel (Cable Must Be Positioned As Shown)
d - W.O.T. Throttle Stop
e - W.O.T. Throttle Stop Screw
f - Washer and Nut (DO NOT Over-Tighten)
g - Throttle Lever

Figure 1. MCM 120R/140R

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART C - MCM 470-485-488



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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Drive Unit Shift Cable Brass Barrel	Spread Cotter Pin	
Cable End Guide	(Note 1)	
Front Engine Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings Large	20-25 (27-34)	
Small		96-108 (11-12)
Rear Engine Mounts	35-40 (47-54)	
Remote Control Shift Cable Brass Barrel	Securely	
Cable End Guide	(Note 1)	
Remote Control Throttle Cable Brass Barrel	Securely	
Cable End Guide	(Note 1)	
Upper Exhaust Pipe		180 (20)

NOTE 1: Tight, then back nut off 1/2 turn.

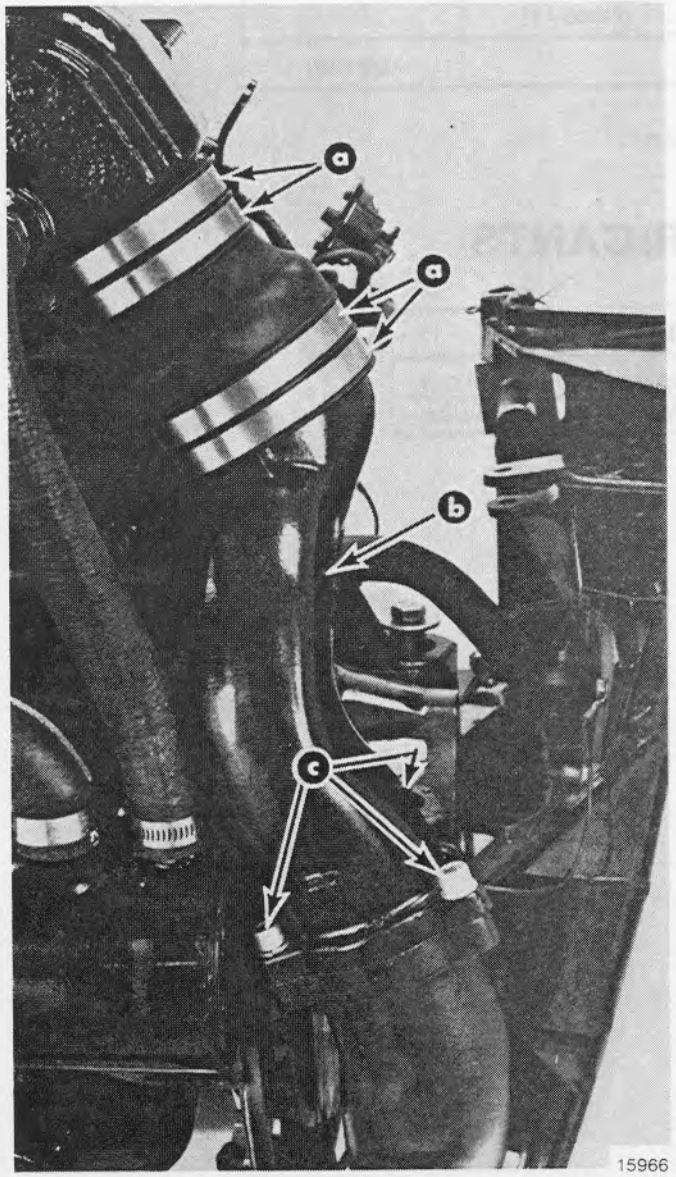
TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Multi-Lube

REMOVAL

NOTICE
Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual."

1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. **MCM 470/485:** Disconnect shift cutout switch wires from terminal block (located on shift plate).
   MCM 470/470R/485/488R: Disconnect trim position sender wires from terminal block.
4. Remove red and black Power Trim pump motor wires from engine (some models).
5. Disconnect water inlet hose and exhaust elbow bellows.
   MCM 470R/485/488R: To remove engine from boat, it may be necessary to remove upper exhaust pipe as shown in Figure 1.
6. **MCM 470/485:** Remove drive unit shift cable from "J" clamp (located on flywheel housing).
   MCM 470R/488R: Remove both shift cables from shift plate assembly (located on exhaust manifold).
7. Disconnect any grounding wire or accessories that are connected to the engine.
8. **Power Steering Models:** Disconnect fluid hoses from power steering control valve.
9. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
10. Carefully remove engine.

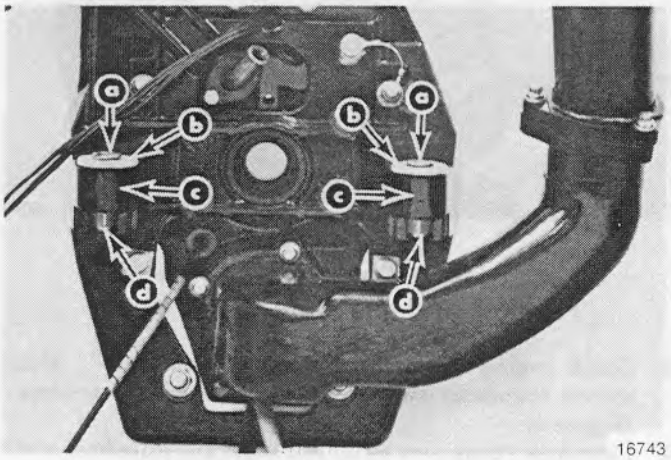


a - Clamps
b - Upper Exhaust Pipe
c - Socket Head Screws

Figure 1. MCM 470R/485/488R

INSTALLATION

1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Lubricate engine coupling splines with 2-4-C Multi-Lube.
3. Place large fiber washer on top of transom plate engine mounting brackets and double wound lockwasher inside fiber washer. (Figure 1)



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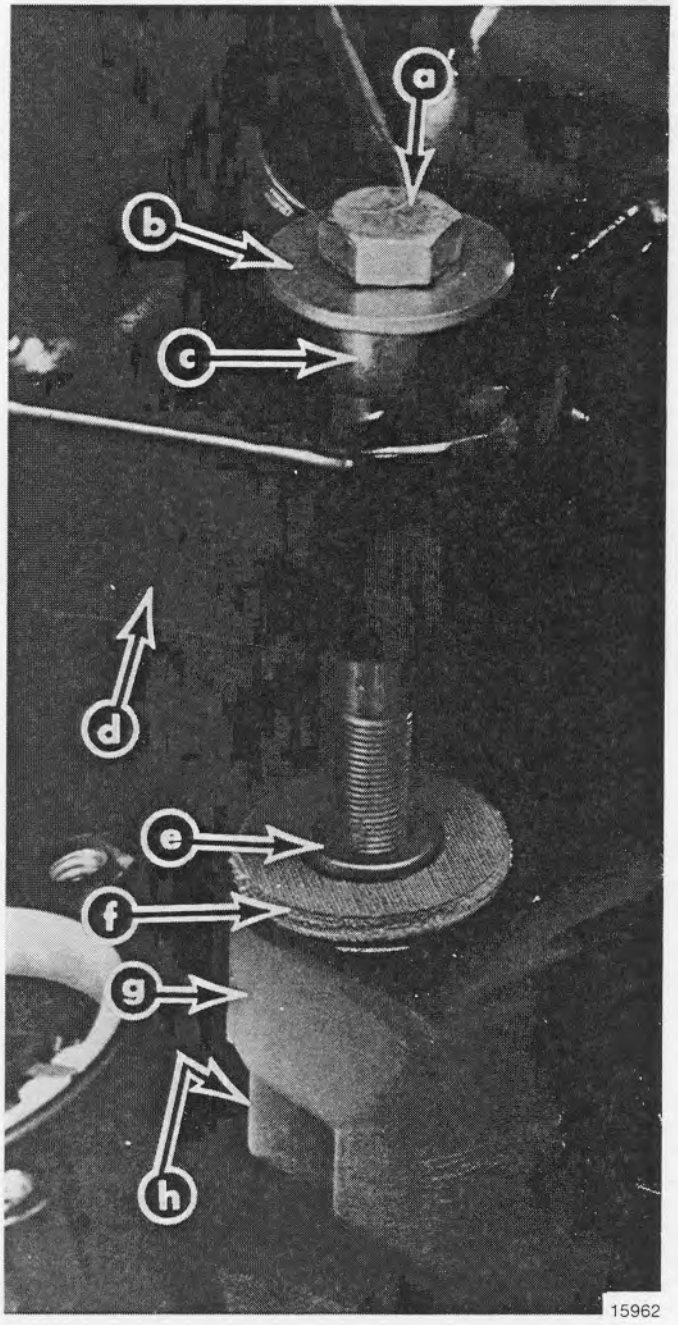
a - Double Wound Lockwasher
b - Fiber Washer
c - Mounting Bracket
d - Elastic Stop Nuts (Engine Mounting Bolts)

Figure 1. Transom Plate

4. Place engine over transom plate mounting brackets. Place hose clamps over rubber exhaust elbow bellows and position bellows over exhaust manifold outlet.
5. Place steel washers and spacers on mounting bolts and insert bolts down thru rear engine mounts. (Figure 2) washers and mounting brackets. Thread elastic stop nuts on bolts. Torque to specification.
6. **MCM 470R/485/488R:** If removed. connect upper exhaust pipe to lower exhaust pipe as shown in Figure 3.
   All Models: Tighten exhaust bellow clamps securely. (Figure 3)
7. Secure front engine mount to boat. (Figure 4)



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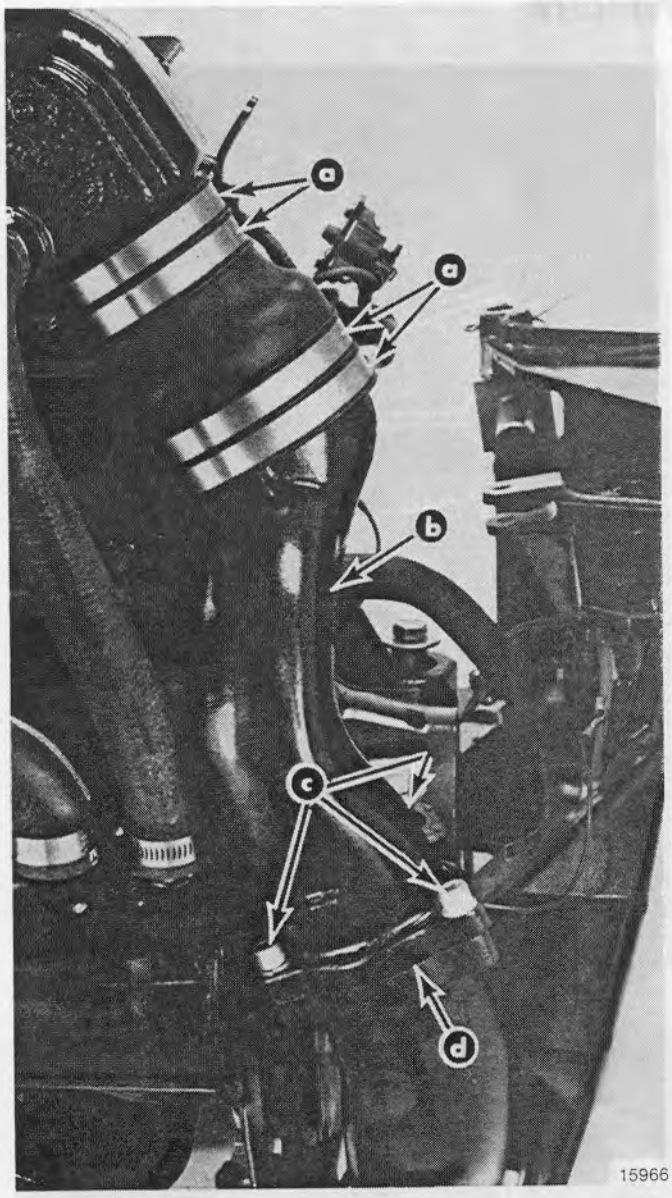
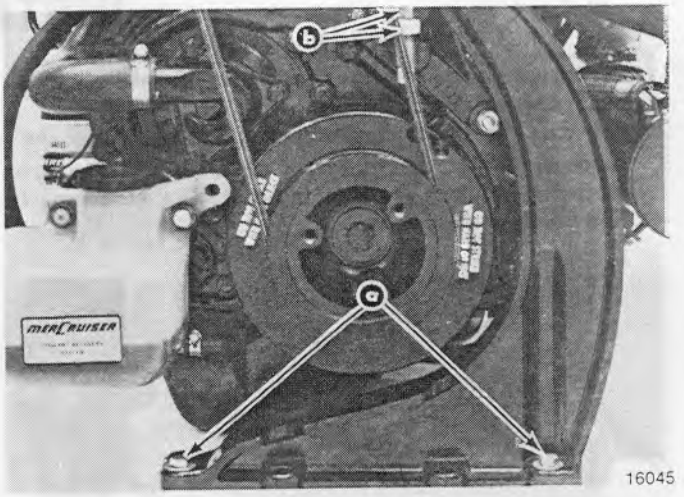
a - Rear Engine Mounting Bolts
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer
g - Mounting Brackets
h - Elastic Stop Nut (Hidden)

Figure 2. Securing Rear Engine Mounts



a - Clamps
b - Upper Exhaust Pipe
c - Socket Head Screws (Torque to Specifications)
d - MCM 485 - Gasket, MCM 470R/488R - "O" Ring

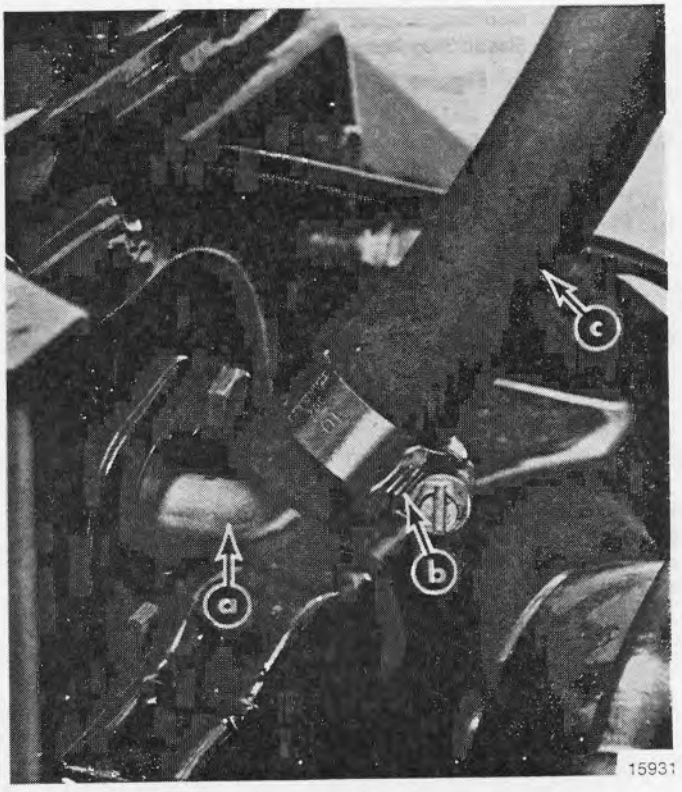
Figure 3. Exhaust System Connection



a - Mounting Bolts
b - Lower Nuts

Figure 4. Securing Front Engine Mount

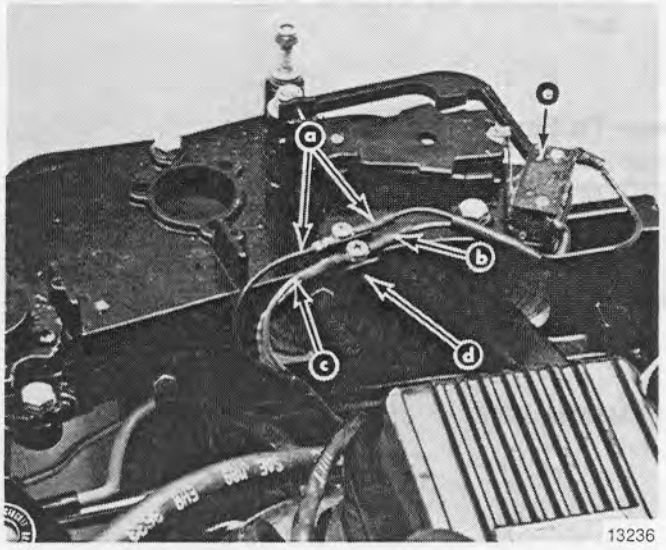
8. Check engine alignment. Refer to "Alignment". After correct alignment is attained, tighten lower nuts securely. (Figure 4)
9. Place hose clamp over water inlet hose and place hose over inlet tube. (Figure 5) Tighten clamp securely.



a - Water Tube
b - Hose Clamp
c - Water Hose

Figure 5. Water Hose Connection

10. Connect instrument harness to engine harness. Secure with clamp and tighten securely.
11. **MCM 470/485:** Connect shift cutout switch wires as shown in Figure 6.
    MCM 470/470R/485/488R: Connect trim position sender wires as shown in Figure 7.

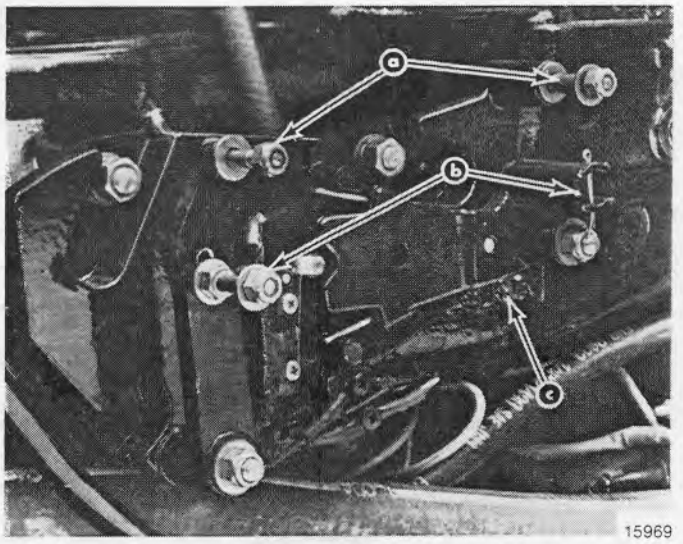


a - Black Wire
b - Brown, Gray or White/Green Wire — To Insulated Terminal
c - Brown or Gray Wire — To Insulated Terminal
d - Terminal Block
e - Shift Cutout Switch

Figure 6. MCM 470/485

a - Terminal Block
b - Brown or Purple Sleeve — To Insulated Terminal
c - Brown/White Wire — To Insulated Terminal
d - Without Sleeve - To Terminal Block Mounting Screw

Figure 7. MCM 470/470R/485/488R



a - Remote Control Shift Cable Attaching Points
b - Drive Unit Shift Cable Attaching Points
c - Exhaust Manifold

Figure 8. MCM 470R/488R

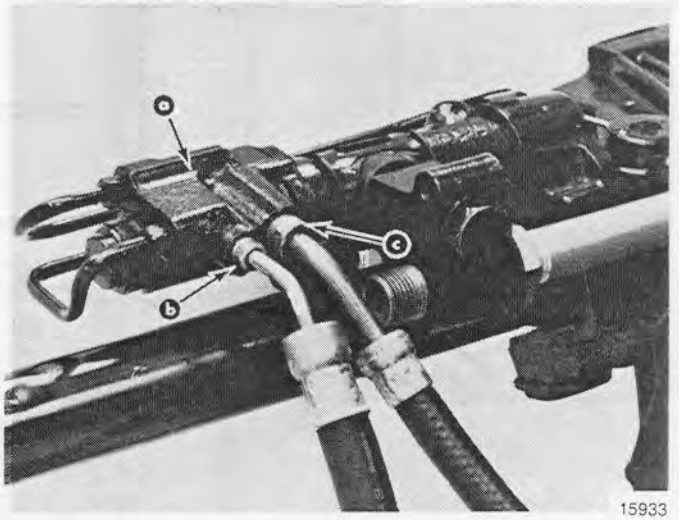
12. Connect fuel line. Check for fuel leaks.
13. **MCM 470/485:** Place drive unit shift cable in "J" clamp (located on flywheel housing) and bend clamp closed.
    MCM 470R/488R: Connect drive unit and remote control shift cables as shown in Figure 8.

    IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".

14. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
15. Connect red and black trim pump wires (some models).
16. Connect any ground wires or accessories that may have been disconnected.
17. **Power Steering Models:** Reconnect fluid hoses as shown in Figure 9.

    IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".

18. Connect battery cables to battery.



a - Control Valve
b - Small Fitting — Torque to Specifications
c - Large Fitting — Torque to Specifications

Figure 9. Power Steering Connections

ALIGNMENT

To ensure more engine coupler engagement during the alignment of MCM 470R and 488R model engines, modify the alignment tool as shown in Figure 1. This modification will improve engine coupler engagement on the other model engines also.

IMPORTANT: DO NOT remove more than .560" from gimbal bearing area of alignment tool. This .560" dimension ensures that the gimbal bearing will straddle the existing "under cut" in alignment tool.

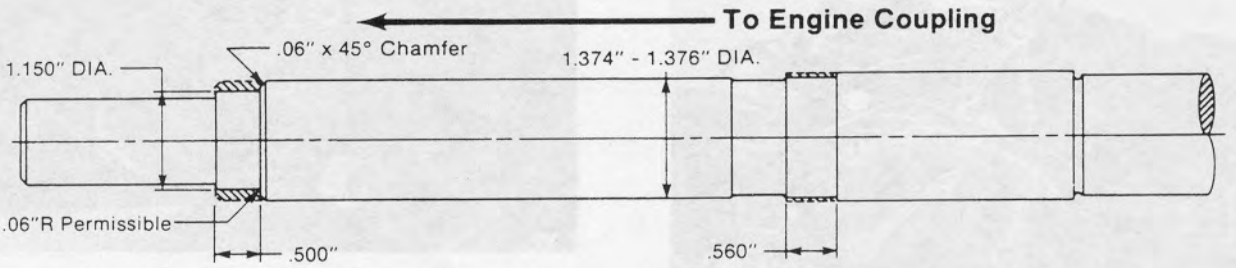


Figure 1. Alignment Tool Modification

1. Using Alignment Tool (91-57797A3), insert end of shaft (which does not have threaded hole) thru gimbal bearing. Move gimbal bearing, as required, to insert shaft into engine coupling. (Figure 2)

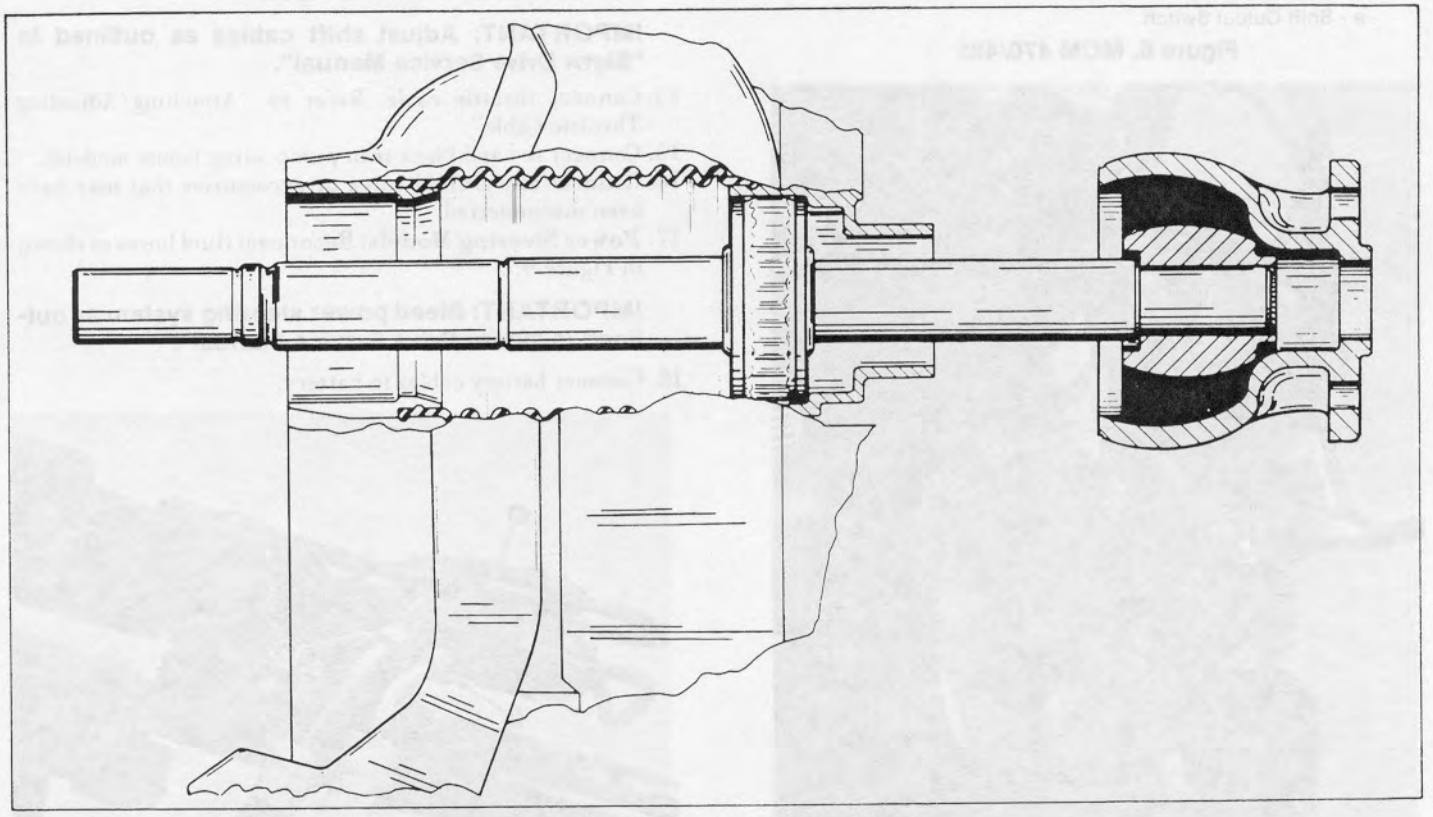
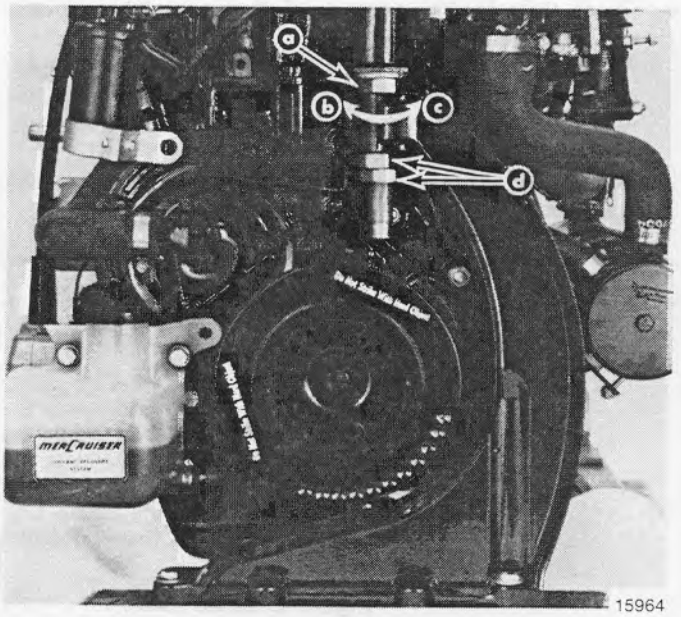


Figure 2. Alignment Tool Inserted

2. If shaft enters coupling freely with no pressure, alignment is correct. If not, proceed as follows:
   a. Loosen front mount adjusting nuts and thread either way to raise or lower front of engine until alignment is correct. (Figure 3)
   b. After correct alignment shaft fit is attained, tighten lower nuts securely. Recheck alignment shaft fit.

a - Upper Nut
b - Raise
c - Lower — Front of Engine
d - Lower Nuts

Figure 3. Adjusting Front Mount



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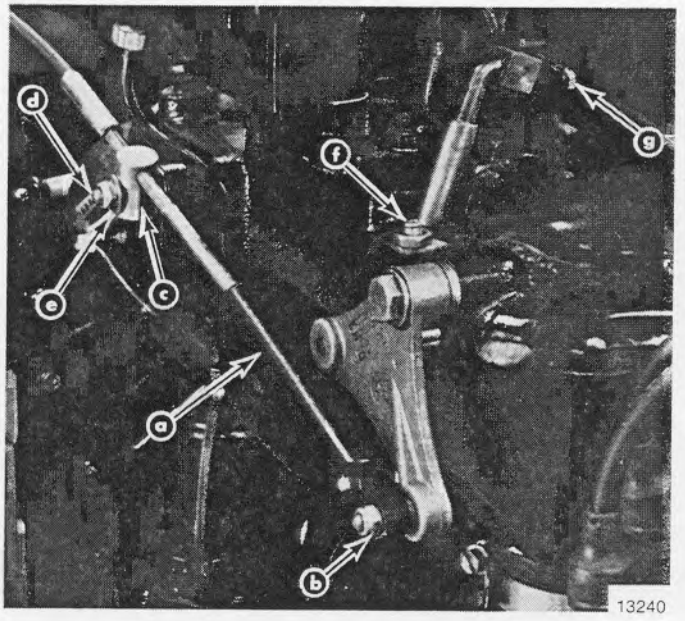
ATTACHING/ADJUSTING THROTTLE CABLE

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown in Figure 1 or 2.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown in Figure 1 or 2.

a - Cable End Guide
b - Washer and Nut (DO NOT Over-Tighten)
c - Brass Barrel
d - Stud
e - Washer and Nut (DO NOT Over-Tighten)
f - W.O.T. Stop Screw
g - Idle Stop Screw

Figure 1. MCM 470/470R/485



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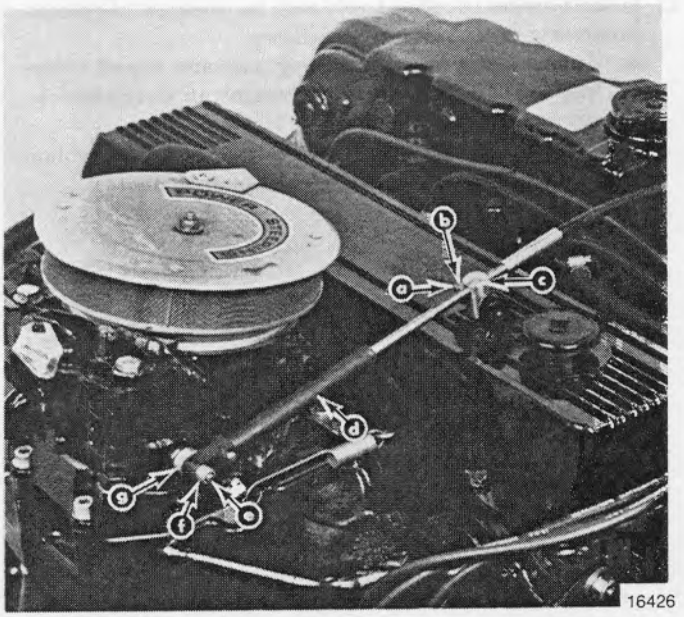
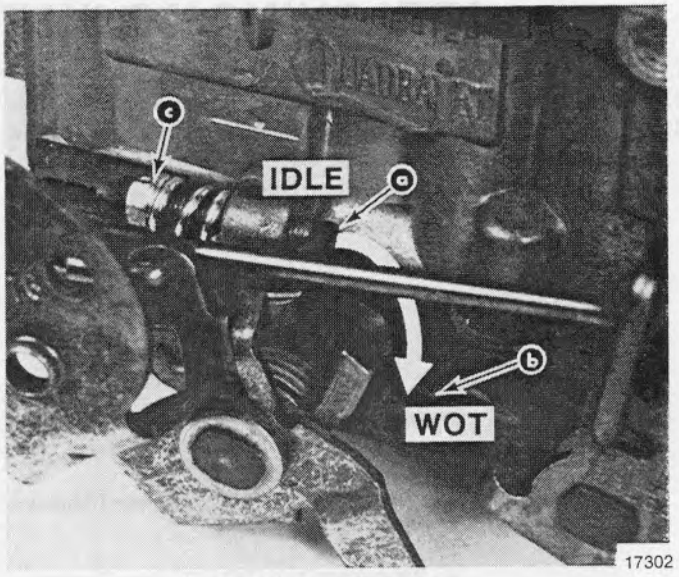
4. Check that throttle valves are fully open when remote control is in full throttle position. (Figure 1 or 3)
   MCM 470/470R/485: With throttle valves fully open, check wide open throttle stop screw. Turn screw until it just touches stop, then turn ¼ turn more. Tighten set nut securely to prevent stop screw from turning.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop. (Figure 1 or 3)



a - Anchor Stud
b - Washer and Nut (DO NOT Over-Tighten)
c - Brass Barrel
d - Cable End Guide
e - Screw
f - Washer and Nut (DO NOT Over-Tighten)
g - Bushing

Figure 2. MCM 488R

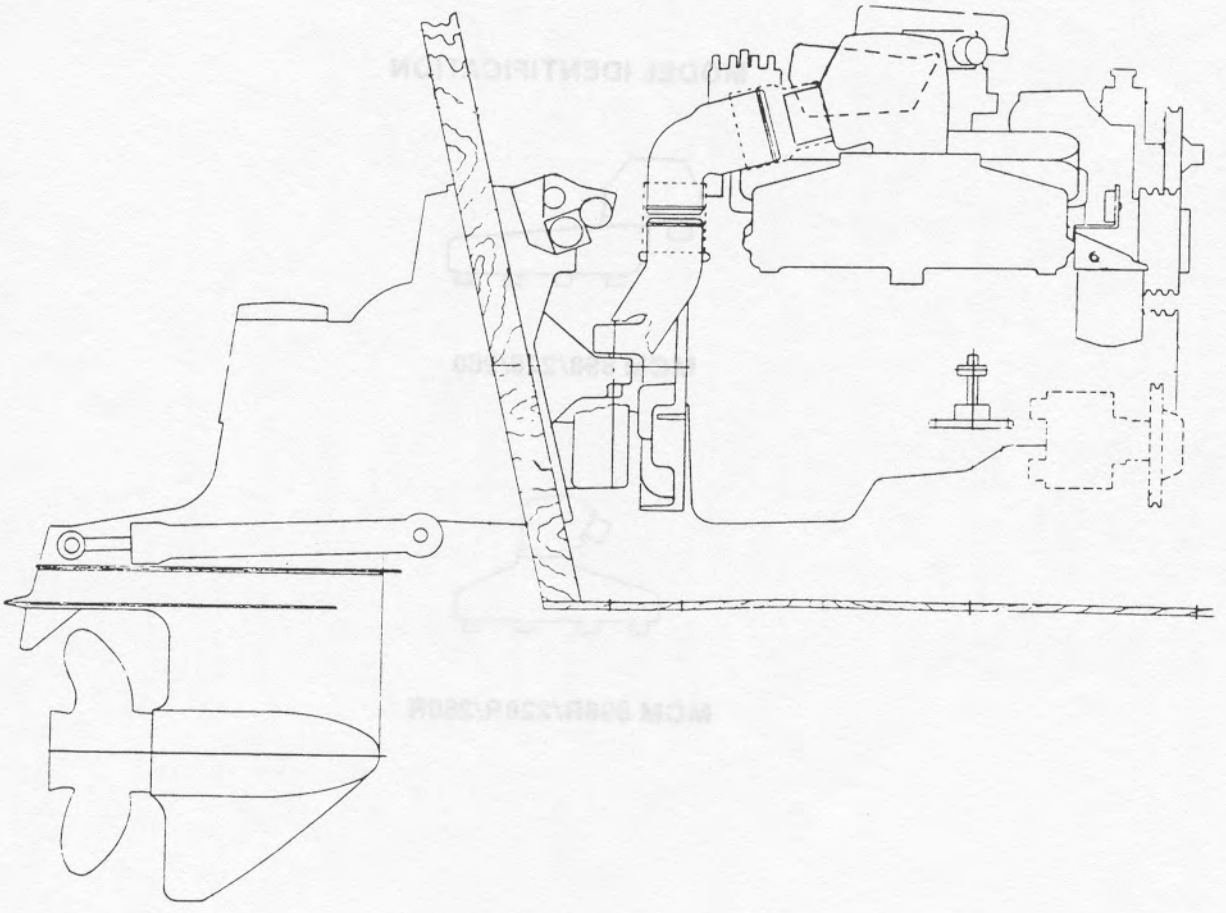


a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

Figure 3. MCM 488R

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART D - MCM 898-228-260



MERCURY MARINE
A BRUNSWICK COMPANY

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STERN DRIVES & INBOARDS

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Removal	2D-2
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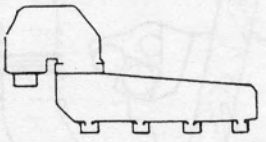
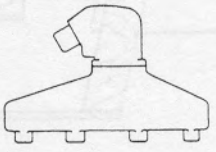
Attaching/Adjusting Throttle Cable	2D-7

MODEL IDENTIFICATION



MCM 898/228/260



MCM 898R/228R/260R

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Drive Unit Shift Cable Brass Barrel	Spread Cotter Pin	
Cable End Guide	(Note 1)	
Front Engine Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings Large	20-25 (27-34)	
Small		96-108 (11-12)
Rear Engine Mounts	35-40 (47-54)	
Remote Control Shift Cable Brass Barrel	Securely	
Cable End Guide	(Note 1)	
Remote Control Throttle Cable Brass Barrel	Securely	
Cable End Guide	(Note 1)	

NOTE 1: Tighten, then back nut off 1/2 turn.

TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Multi-Lube

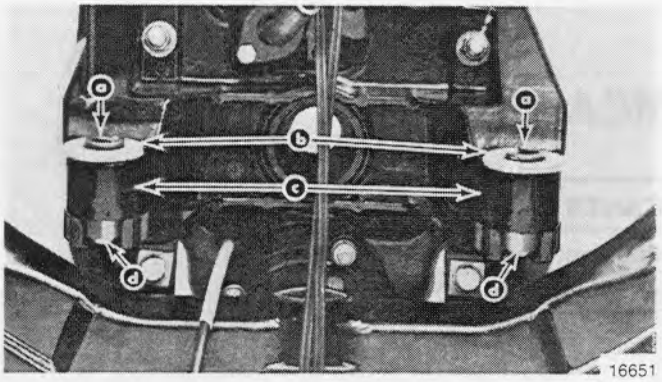
REMOVAL

NOTICE
Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual".

1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. **MCM 898/228/260:** Disconnect trim position sender wires (coming from gimbal housing) from terminal block on engine harness mounting plate.
   MCM 898R/228R/260R: Disconnect trim position sender wires (coming from gimbal housing) from terminal block on circuit breaker/solenoid mounting bracket. After wires are disconnected, remove wires from clamps that hold the power steering hoses.
4. **MCM 898/228/260 only:** Remove plastic tubing and gray hydraulic hose from Power Trim reverse lock valve.
5. Remove red and black Power Trim pump motor wires from engine (some models).
6. Disconnect water inlet hose and exhaust elbow bellows.
7. Remove both shift cables from shift plate.
8. Disconnect any grounding wire or accessories that are connected to the engine.
9. **Power Steering Models:** Disconnect fluid hoses from power steering control valve.
10. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
11. Carefully remove engine.

INSTALLATION

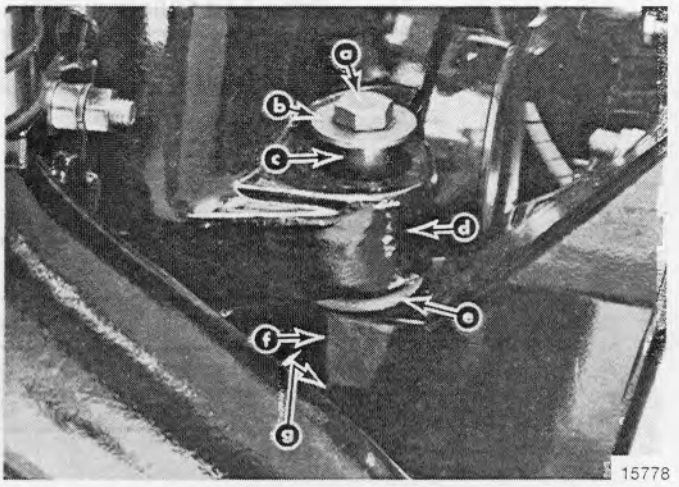
1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Lubricate engine coupling splines with 2-4-C Multi-Lube.
3. Place large fiber washer on top on transom plate engine mounting brackets and double wound lockwasher inside fiber washer. (Figure 1)



a - Double Wound Lockwasher
b - Fiber Washer
c - Mounting Bracket
d - Elastic Stop Nuts (Engine Mounting Bolts)

Figure 1. Transom Plate

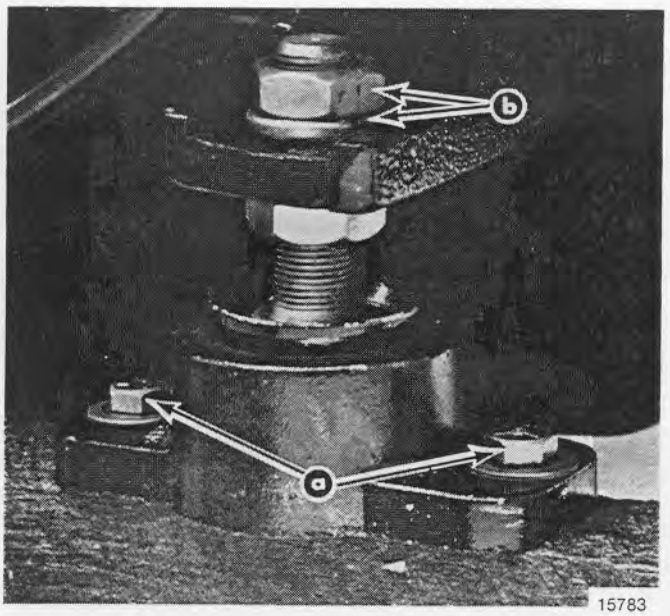
4. Place engine over transom plate mounting brackets. Place hose clamps over rubber exhaust elbow bellows.
5. Place steel washers and spacers on mounting bolts and insert bolts down thru rear engine mounts. (Figure 2) washers and mounting brackets. Thread elastic stop nuts on bolts. Torque to specification.



a - Rear Engine Mounting Bolts
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Fiber Washer With Double Wound Lockwasher in the Center
f - Mounting Brackets
g - Elastic Stop Nut (Hidden)

Figure 2. Securing Rear Engine Mounts

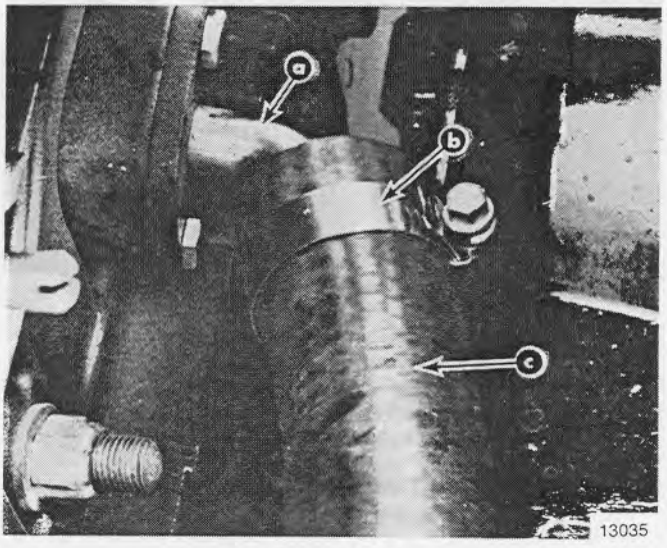
6. Tighten all exhaust bellow clamps securely.
7. Secure front engine mounts to boat. (Figure 3)



a - Mounting Bolts
b - Locknut and Lockwasher

Figure 3. Securing Front Engine Mounts

8. Check engine alignment. Refer to "Alignment". After correct alignment is attained, tighten locknuts securely. (Figure 3)
9. Place hose clamp over water inlet hose and place hose over inlet tube. (Figure 4) Tighten clamp securely.

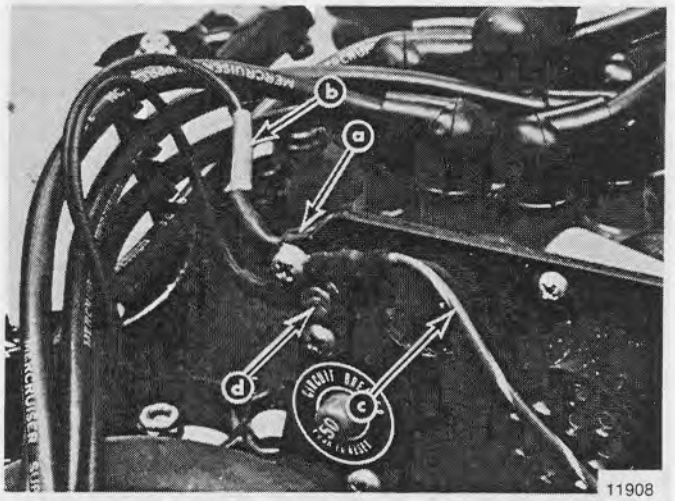


a - Water Inlet Tube
b - Hose Clamp
c - Water Inlet Hose

Figure 4. Water Hose Connection

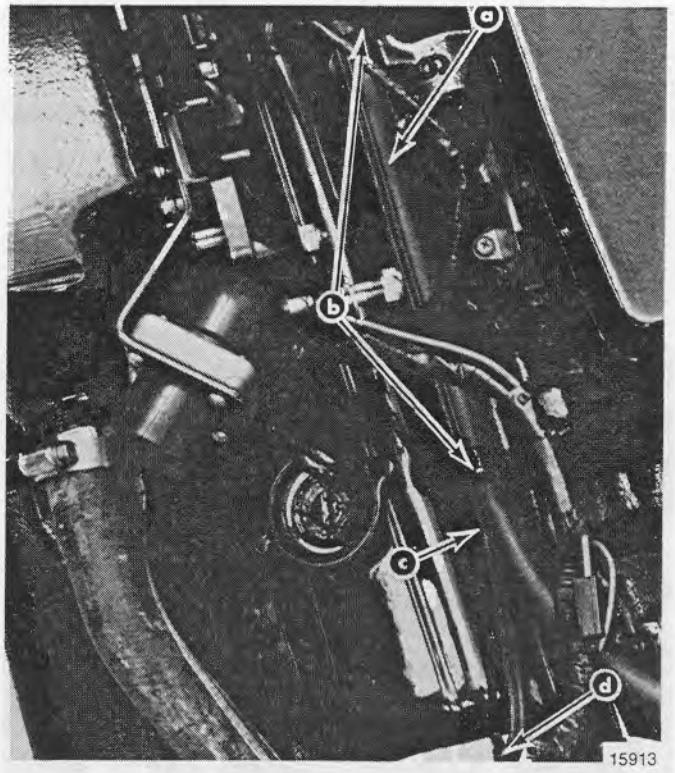
10. Connect instrument harness to engine harness. Secure with clamp and tighten securely.

11. Connect trim position sender wires as follows:
MCM 898/228/260: Figure 5
MCM 898R/228R/260R: Figures 6 and 7.



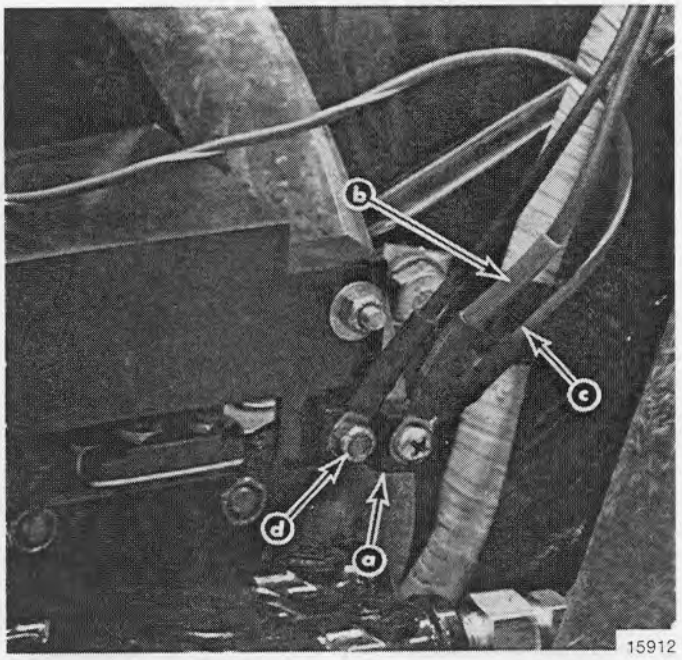
a - Terminal Block
b - Brown or Purple Sleeve — To Insulated Terminal
c - Brown/White Wire — To Insulated Terminal
d - Without Sleeve - To Terminal Block Mounting Screw

Figure 5. MCM 898/228/260



a - Power Steering Hydraulic Hose
b - Hose Clips
c - Trim Position Sender Wires (Route Thru Hose Clips)
d - Sta-Strap Leads at This Location

Figure 6. MCM 898R/228R/260R

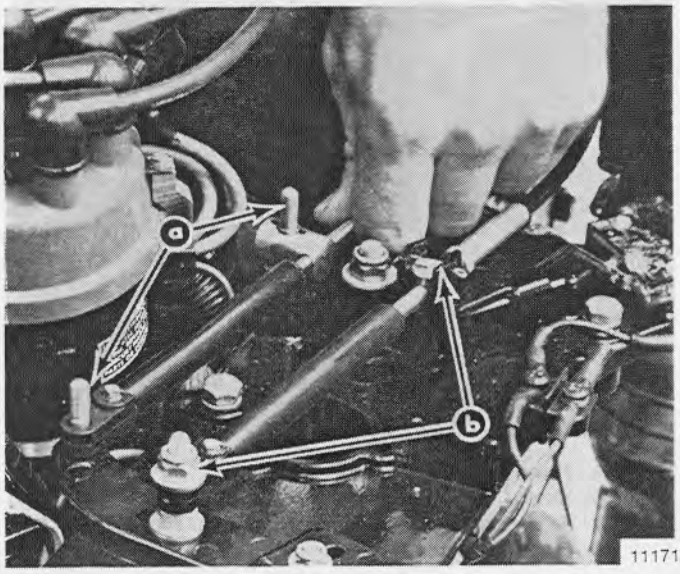


a - Terminal Block
b - Brown or Purple Sleeve — To Insulated Terminal
c - Brown/White Wire — To Insulated Terminal
d - Without Sleeve - To Terminal Block Mounting Screw

Figure 7. MCM 898R/228R/260R

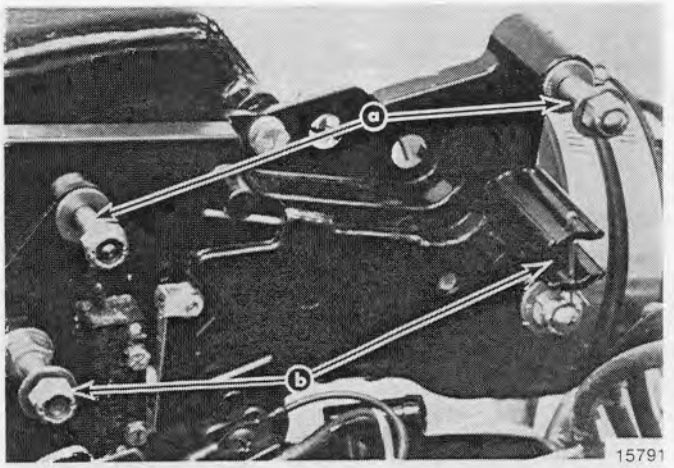
12. Connect fuel line. Check for fuel leaks.
13. Connect drive unit and remote control shift cables as follows:
MCM 898/228/260: Figure 8
MCM 898R/228R/260R: Figure 9

IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".



a - Remote Control Shift Cable Anchor Points
b - Drive Unit Shift Cable Anchor Points

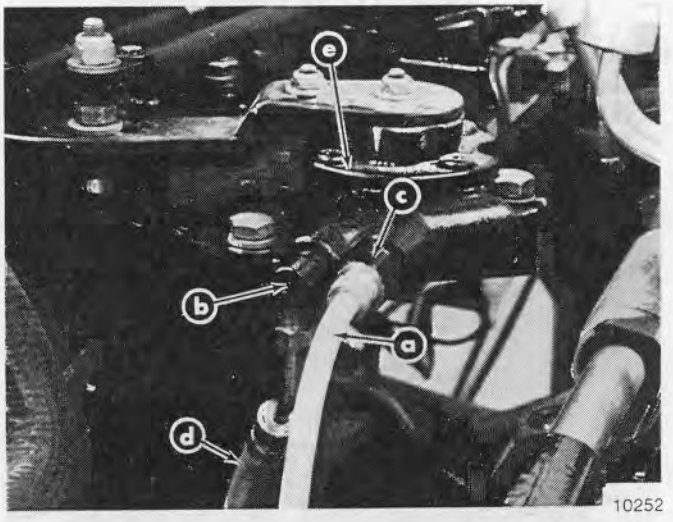
Figure 8. MCM 898/228/260



a - Remote Control Shift Cable Anchor Points
b - Drive Unit Shift Cable Anchor Points

Figure 9. MCM 898R/228R/260R

14. **MCM 898/228/260 only:** Connect Power Trim hydraulic hoses as shown in Figure 10.



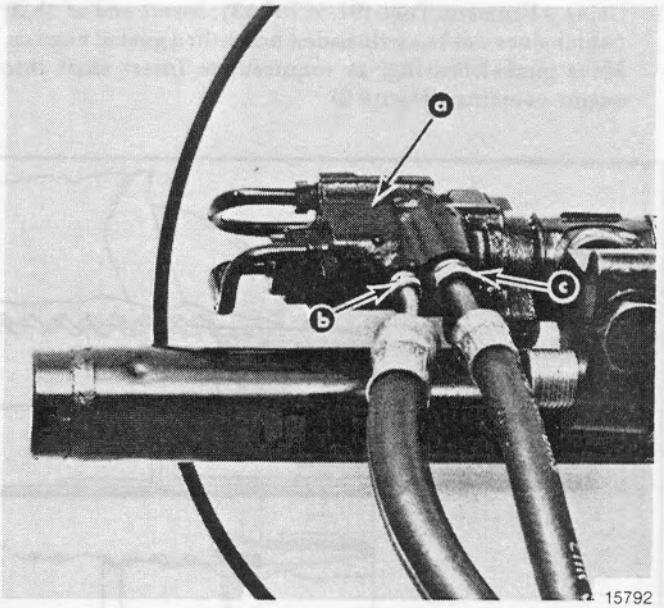
a - White Plastic Tubing (from Power Trim Pump)
b - Elbow Fitting
c - Straight Fitting
d - Gray Hydraulic Hose (from Gimbal Housing)
e - Reverse Lock Valve

Figure 10. Power Trim Hose Connected to Reverse Lock Valve

15. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
16. Connect red and black trim pump wires (some models).
17. Connect any ground wires or accessories that may have been disconnected.
18. **Power Steering Models:** Reconnect fluid hoses as shown in Figure 11.

IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".

19. Connect battery cables to battery.



a - Control Valve
b - Small Fitting
c - Large Fitting
Torque to Specifications

Figure 11. Power Steering Connections

ALIGNMENT

To ensure more engine coupler engagement during the alignment of MCM 898R/228R/260R model engines, modify the alignment tool as shown in Figure 1. This modification will improve engine coupler engagement on the other model engines also.

IMPORTANT: DO NOT remove more than .560" from gimbal bearing area of alignment tool. This .560" dimension ensures that the gimbal bearing will straddle the existing "under cut" in alignment tool.

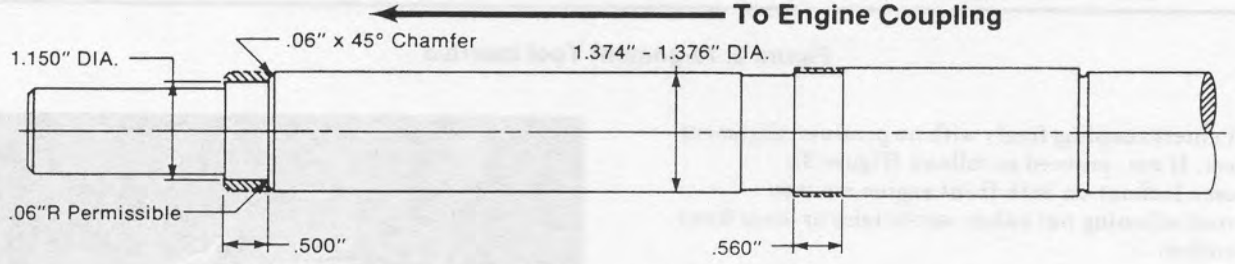


Figure 1. Alignment Tool Modification

1. Using Alignment Tool (91-57797A3), insert end of shaft (which does not have threaded hole) thru gimbal bearing. Move gimbal bearing, as required, to insert shaft into engine coupling. (Figure 2)

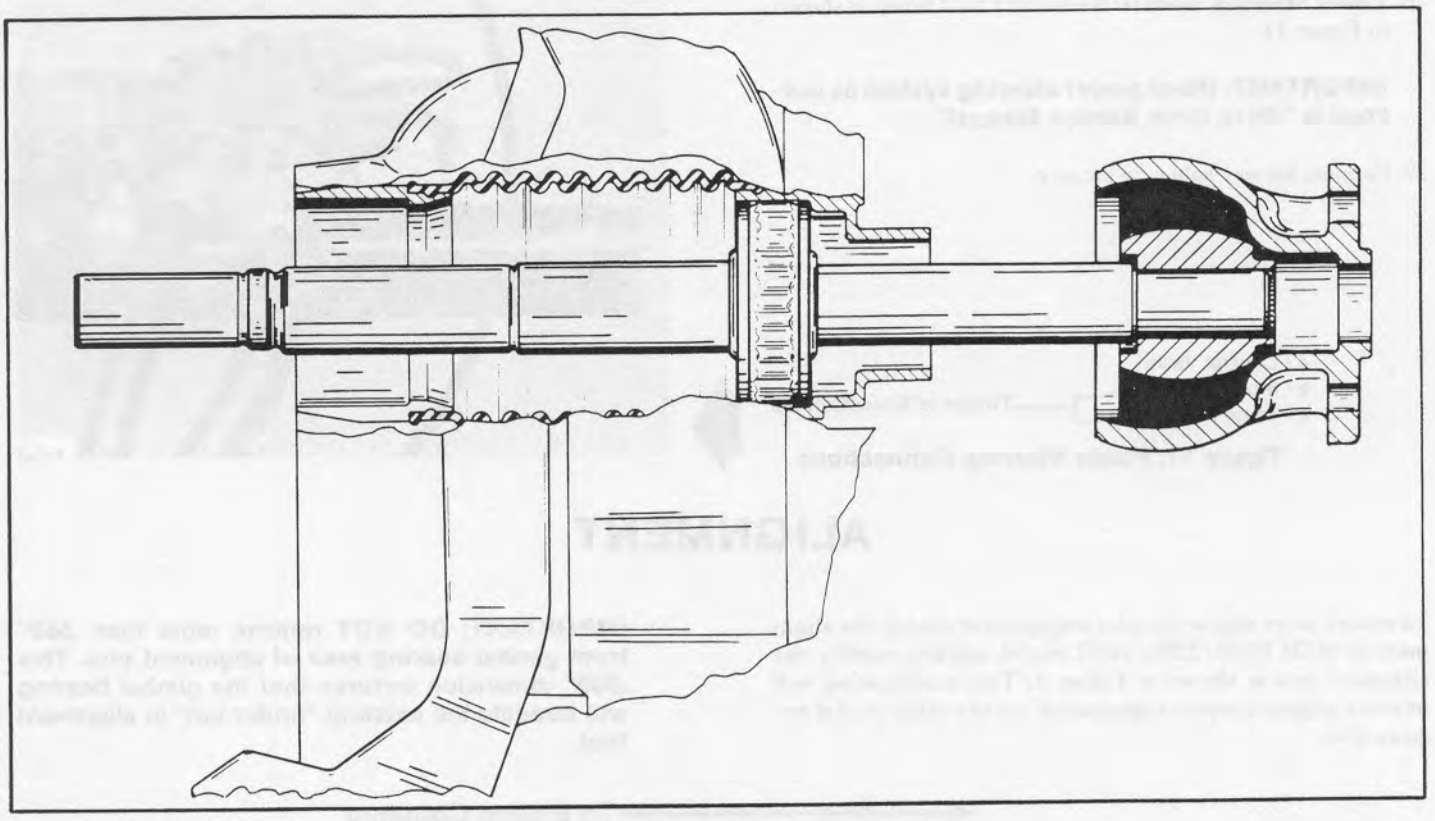
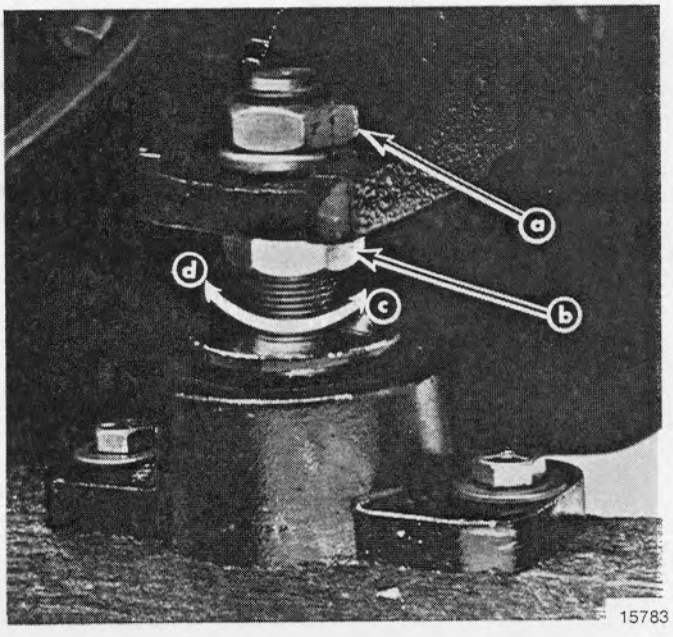


Figure 2. Alignment Tool Inserted

2. If shaft enters coupling freely with no pressure, alignment is correct. If not, proceed as follows (Figure 3):
   a. Loosen locknut on both front engine mounts.
   b. Thread adjusting nut either way to raise or lower front of engine.

   IMPORTANT: Raise or lower each side of the engine the same amount. Care must be taken not to "cock" front of engine.

   c. After correct alignment shaft fit is attained, tighten locknuts securely. Recheck alignment shaft fit.

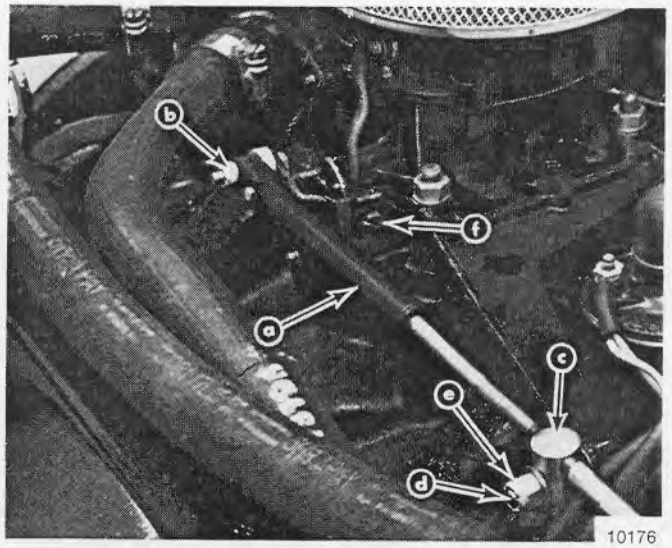


a - Locknut
b - Adjusting Nut
c - Raise
d - Lower
Front of Engine

Figure 3. Adjusting Front Mounts

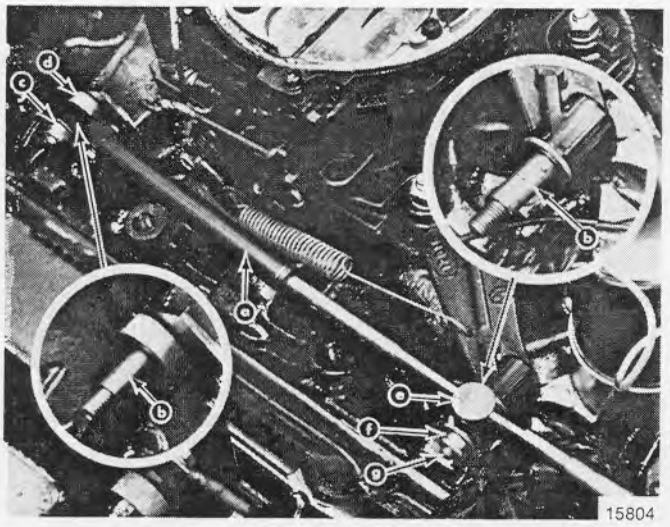
ATTACHING/ADJUSTING THROTTLE CABLE

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown in Figure 1 or 2.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown in Figure 1 or 2.
4. Check that throttle valves are fully open when remote control is at full throttle position. Level tang should be against stop as shown in Figure 3 or 4.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop. (Figure 1 or 4)



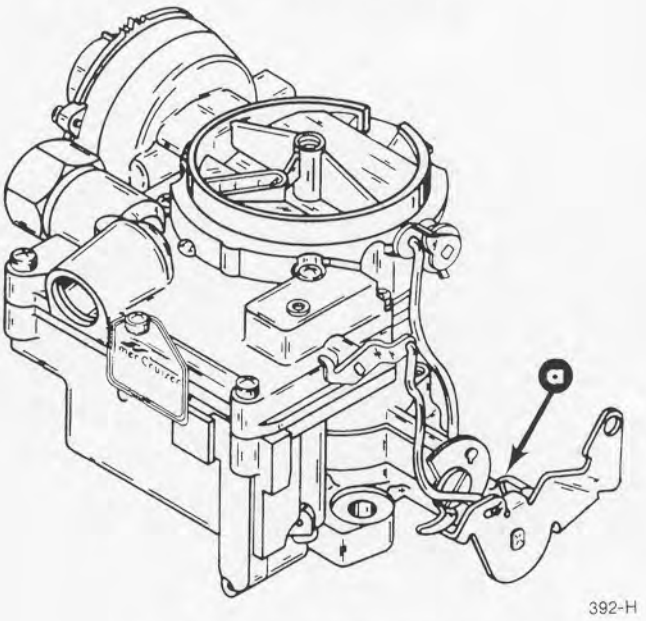
a - Cable End Guide
b - Washer, Nut, Screw and Bushing (DO NOT Over-Tighten)
c - Brass Barrel
d - Stud
e - Washer and Nut (DO NOT Over-Tighten)
f - Idle Stop Screw

Figure 1. MCM 898/898R



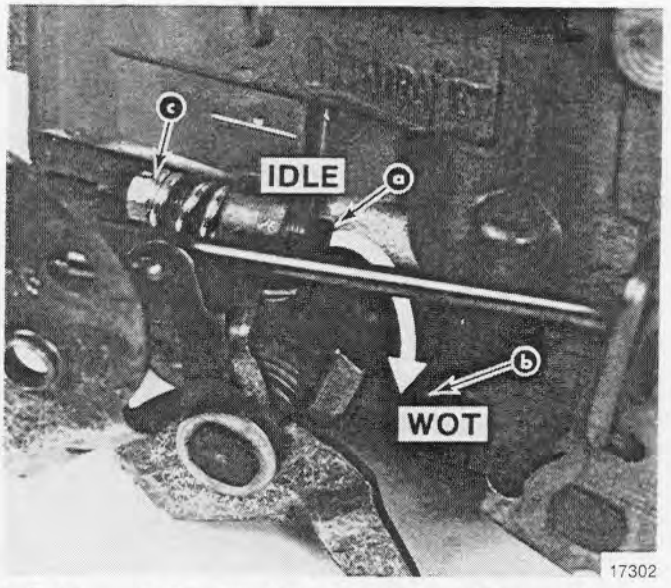
a - Cable End Guide
b - Bushing
c - Washer, Nut and Screw (DO NOT Over-Tighten)
d - Spacer
e - Brass Barrel
f - Washer and Nut (DO NOT Over-Tighten)
g - Anchor Stud

Figure 2. MCM 228/228R/260/260R



a - Throttle Lever Tang Against Stop

Figure 3. MCM 898/898R

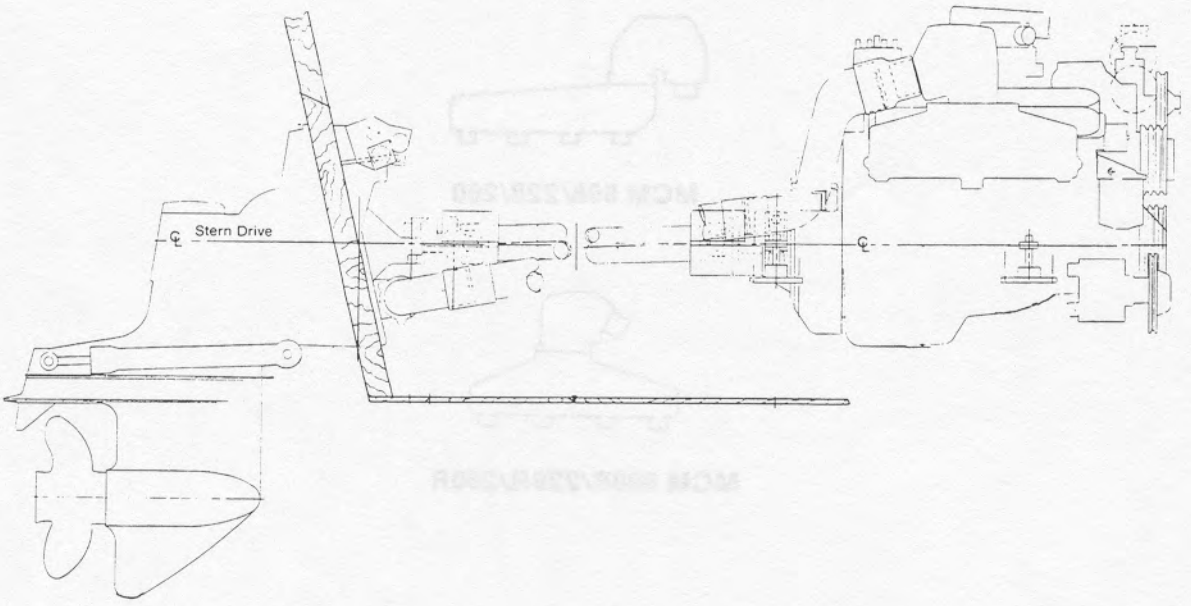


a - Tang b - Carburetor Body c - Idle RPM Adjustment Screw

Figure 4. MCM 228/228R/260/260R

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART E - MCM 898-228-260 DRIVE SHAFT EXTENSION MODELS



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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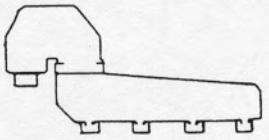
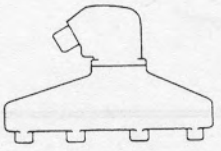
MODEL IDENTIFICATION



MCM 898/228/260



MCM 898R/228R/260R

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Battery Cables	Securely
Bearing Support to Inner Transom Plate	35-40 (47-54)
Drive Shaft	50 (68)
Drive Shaft Shield	30 (41)
Extension Housing to Flywheel Housing	30 (41)
Flywheel Housing	30 (41)
Front and Rear Engine Mounts	Securely
Hose Clamps	Securely
Rear Engine Mount Bracket	50 (68)
Remote Control Throttle Cable Brass Barrel Cable End Guide	Securely (Note 1)

NOTE 1: Tighten, then back nut off 1/2 turn.

TOOLS/LUBRICANTS

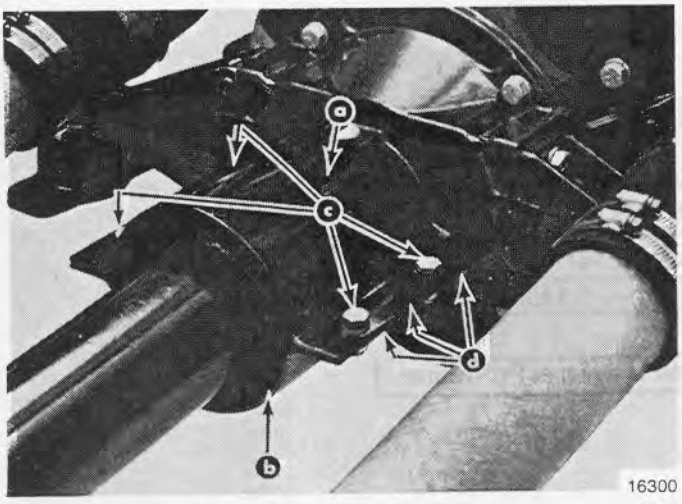
TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Multi-Lube

9-GT-3984	Sears Craftsman Universal Protractor

REMOVAL

NOTICE
Stern drive unit does not have to be removed prior to engine removal. If stern drive is going to be removed, refer to "Stern Drive Service Manual."

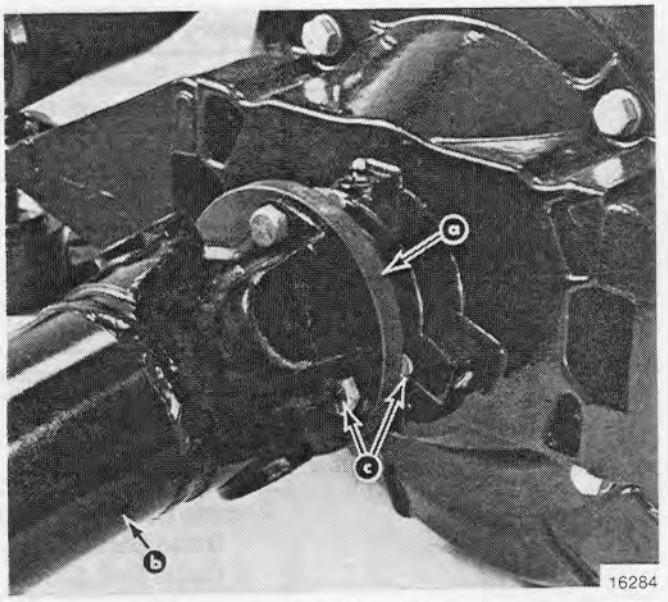
1. Disconnect battery cables from battery and remove instrument harness plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Slide sleeves back on black and white/green (or gray) wires and disconnect engine harness wires from shift cut-out switch harness.
4. Disconnect trim position sender brown/white wire from terminal block on engine.
   MCM 898/228/260: Terminal block located above circuit breaker on engine harness mounting bracket.
   MCM 898R/228R/260R: Terminal block located on circuit breaker/solenoid mounting bracket. After wires are disconnected, remove wires from clamps that hold the power steering hoses.
5. Disconnect water inlet hose (from engine seawater pump).
6. Disconnect exhaust pipes from exhaust hoses.
7. Remove top shield and then bottom shield. (Figure 1)



a - Top Shield
b - Bottom Shield
c - 4 Screws/Nuts (2 Hidden)
d - 3 Screws (Hidden)

Figure 1. Top/Bottom Shield Removal

8. Disconnect drive shaft from output flange. (Figure 2)



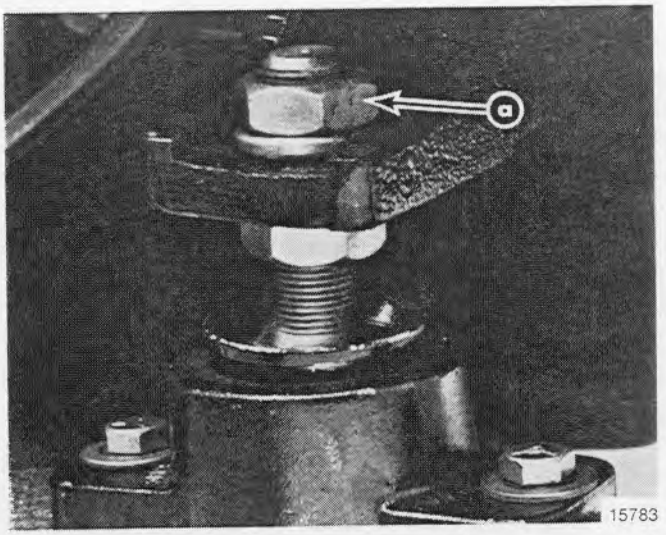
a - Output Flange
b - Drive Shaft
c - Screw/Nut (4)

Figure 2. Disconnecting Drive Shaft

9. Disconnect fluid hoses from power steering control valve (located on transom plate).
10. Disconnect any grounding wire or accessories that are connected to the engine.

IMPORTANT: To avoid the need for a complete realignment (after engine repair), DO NOT move front or rear mounts. Remove mounting bolts as shown in Figure 3.

11. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts, as shown in Figure 3.
12. Carefully remove engine.



a - Mounting Bolts

Figure 3. Front and Rear Mounts

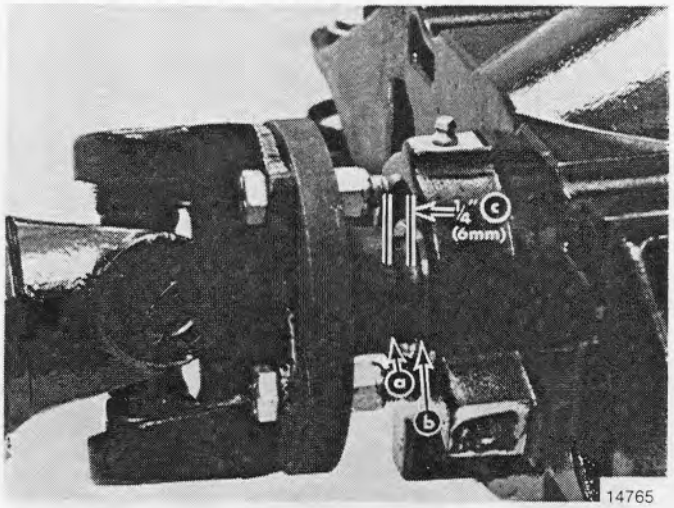
INSTALLATION

NOTICE
If engine mounts or drive shaft have been changed, refer to "Alignment" before starting installation.

1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Set engine on stringers.
3. Connect drive shaft to output flange. Torque screws and nuts to specifications.
4. Relieve hoist tension from engine; then slide engine fore or aft as needed to obtain a ¼" (6mm) between flange shoulder and extension shaft housing bearing. (Figure 1)

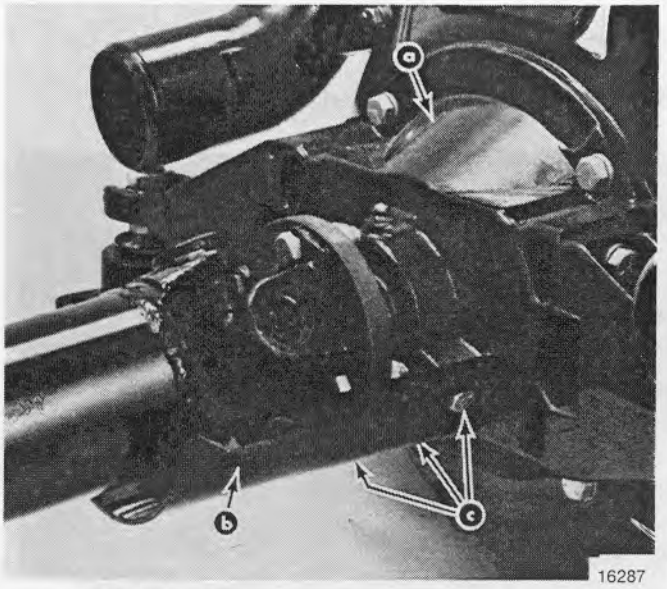
IMPORTANT: Failure to properly position output shaft flange may result in bearing damage.

5. Position engine for correct engine and drive shaft lateral alignment as follows (Figure 2):
   a. The distance between the center of the bearing support attaching bolts on inner transom plate and grease fitting on shaft extension housing MUST BE equal. If not, slide aft end of engine to one side or the other until distances are equal.
   b. Measure distance between the center of the bearing support attaching bolts and rear engine mount adjusting bolt. These distances also, MUST BE equal. If not, slide front of engine to one side or the other until distances are equal.
6. After engine has been aligned correctly, fasten front and rear engine mounts to stringers.
7. Install top and bottom shield. Torque screws to specifications. (Figures 3 and 4)



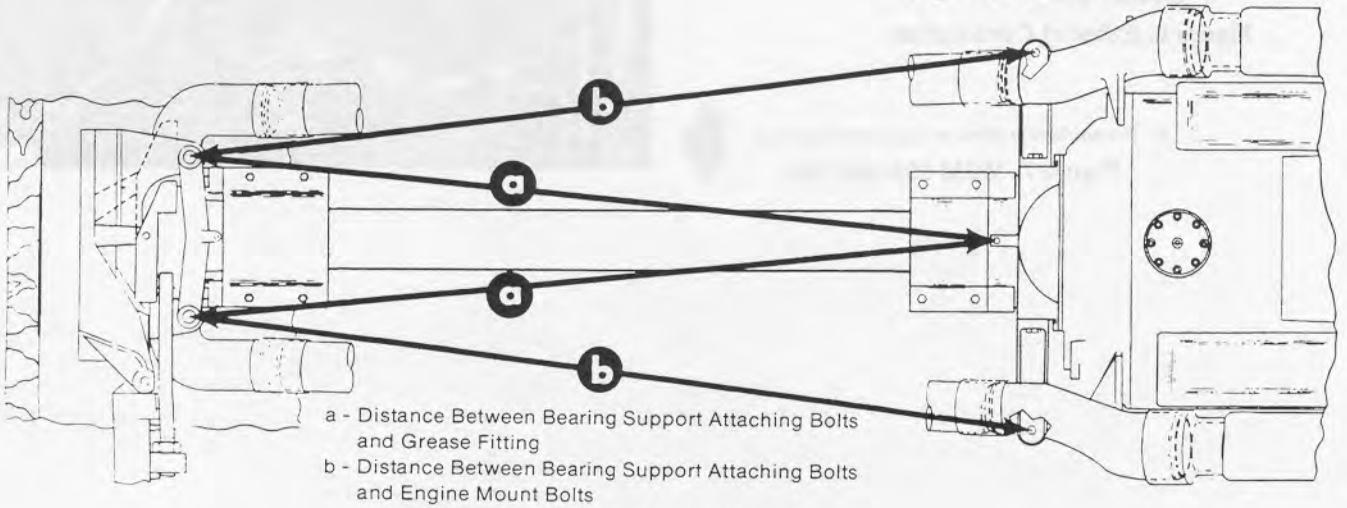
a - Flange Shoulder
b - Bearing
c - 1/4" (6mm)

Figure 1. Distance Between Output Shaft Shoulder and Bearing



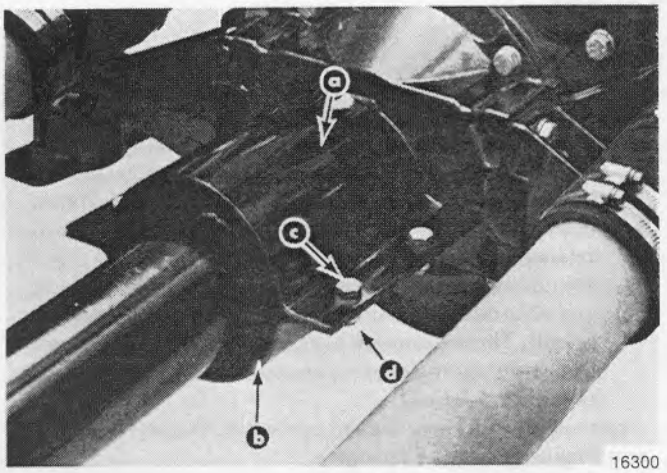
a - Shaft Housing
b - Bottom Shield
c - Screws (Threads of Screws Are Coated with Loctite)

Figure 3. Bottom Shield



a - Distance Between Bearing Support Attaching Bolts and Grease Fitting
b - Distance Between Bearing Support Attaching Bolts and Engine Mount Bolts

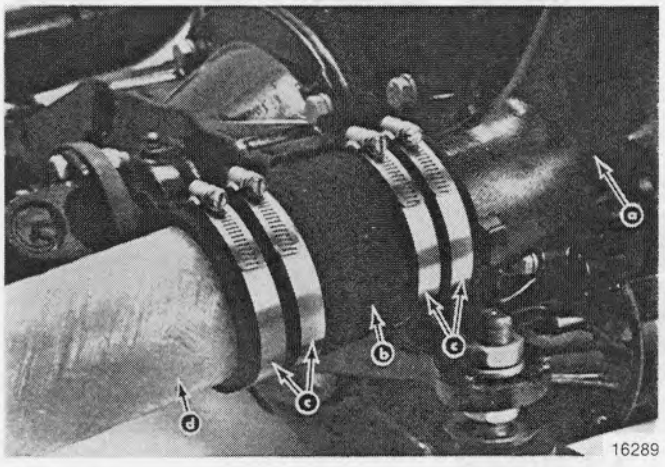
Figure 2. Engine Alignment



a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used)

Figure 4. Top Shield

8. Connect exhaust pipes to exhaust hoses. (Figure 5)



a - Exhaust Pipe
b - Exhaust Hose
c - Clamps (Tighten Securely)
d - Exhaust Tube

Figure 5. Exhaust Connection

9. Connect water inlet hose to seawater pump.
10. Reconnect shift cut-out switch harness to engine harness. (Figure 6)

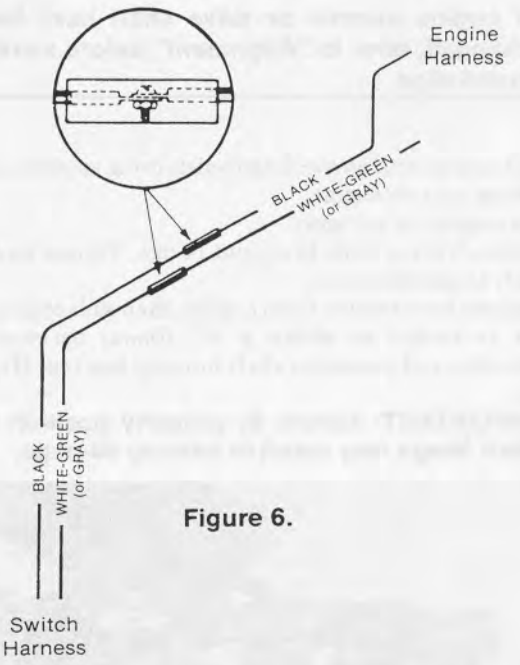
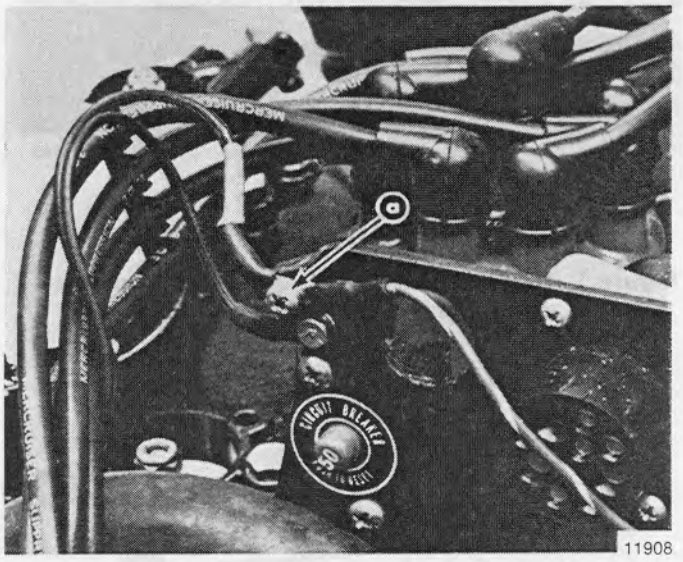


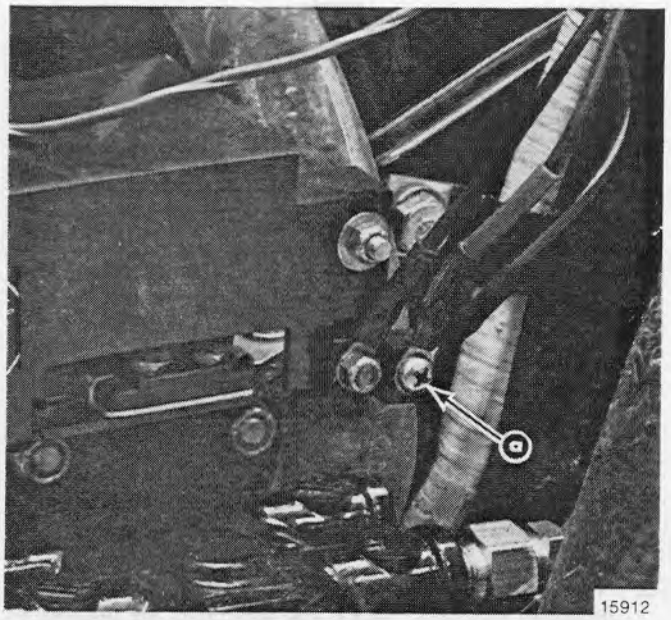
Figure 6.

11. Connect instrument harness to engine harness. Tighten clamp.
12. Connect trim position sender brown/white wire as shown in Figure 7 or 8.



a - Brown/White Wire to Insulated Terminal

Figure 7. MCM 898/228/260



a - Brown/White Wire - Route Thru Clamps That Hold the Power Steering Hoses, Then Connect to Insulated Terminal

Figure 8. MCM 898R/228R/260R

a - Control Valve
b - Small Fitting
c - Large Fitting
Torque to Specifications

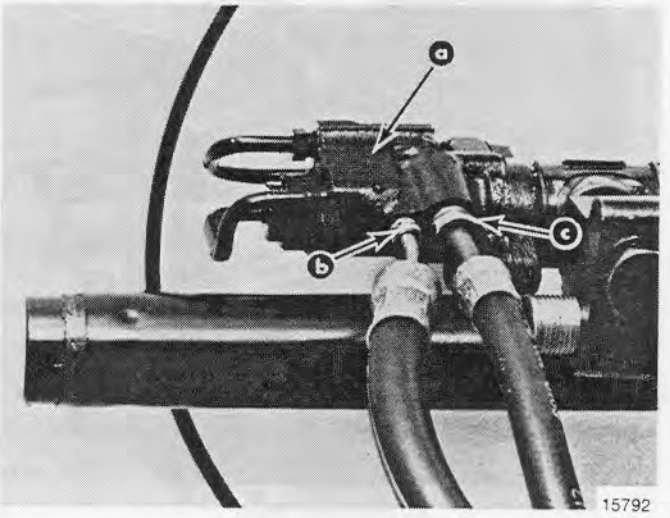
Figure 9. Power Steering Connections

13. Reconnect power steering fluid hoses as shown in Figure 9.

IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".

14. Connect fuel line. Check for leaks.
15. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
16. Connect any grounding wires or accessories that may have been disconnected.
17. Connect battery cables to battery.

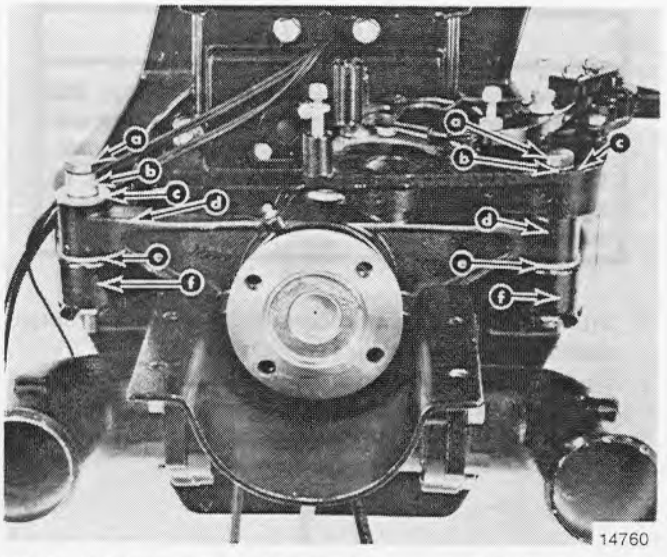
IMPORTANT: If stern drive unit was removed, refer to Step 14 in "Alignment".



ALIGNMENT

BEARING SUPPORT INSTALLATION

MCM 898/228/260: Figure 1

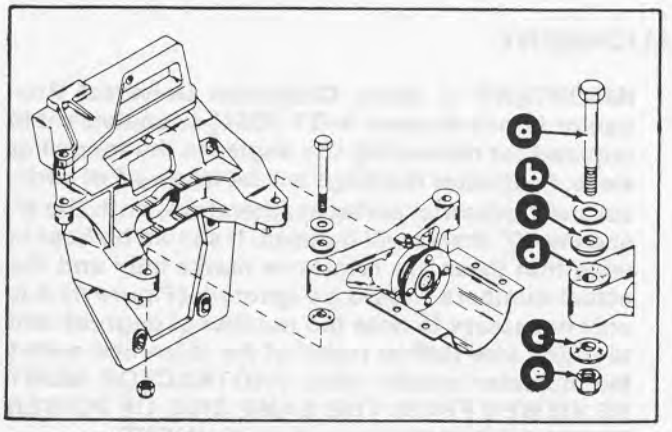


a - Bolt (2) (Torque to Specifications)
b - Spacer (2)
c - Washer (2)
d - Bearing Support
e - Washer (2)
f - Nut (2)

Figure 1. Bearing Support Attaching Parts

MCM 898R/228R/260R: Steps 1, 2 and 3

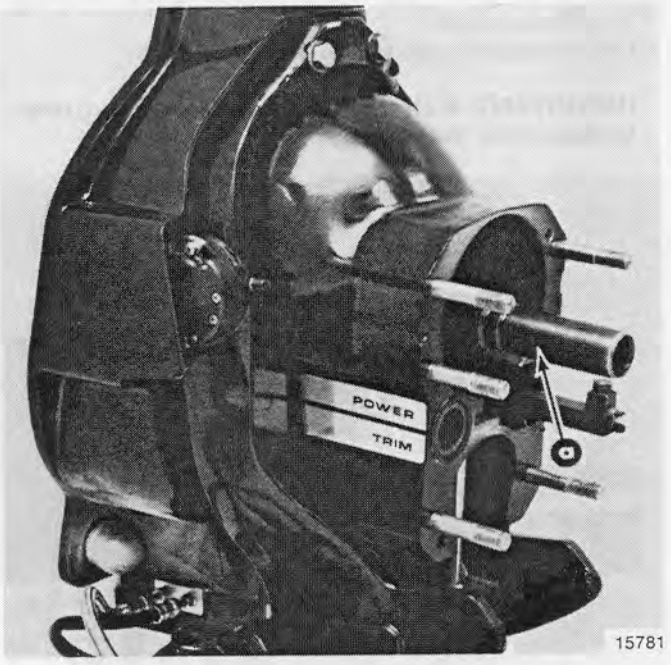
The following procedure MUST BE used when installing bearing support on MCM 898R/228R/260R Models.



a - Bolt (2)
b - Flat Washer (2)
c - Spherical Washer (4) (Install with Rounded Side Toward Bearing Support)
d - Bearing Support
e - Nut (2)

Figure 2. Bearing Support Attaching Parts

1. Install bearing support, as shown in Figure 2. DO NOT tighten bolts.
2. Insert solid end of Alignment Tool (91-57797A3) thru bearing in gimbal housing and into input shaft splines. (Figure 3)
3. Tighten bearing support bolts until snug [5-10 lbs. ft. (7-13 N.m)]. Strike the head of both bolts with a ball peen hammer, then torque bolts to specifications.



a - Alignment Shaft

Figure 3. Alignment Tool Installed

IMPORTANT: Bearing support attaching bolts MUST BE struck with a hammer to properly seat spherical washers. If procedure is not followed, difficulty in installing stern drive unit may result and subsequent damage to bearings may occur from misalignment.

ALIGNMENT

IMPORTANT: A Sears Craftsman Universal Protractor (stock number 9-GT-3984) or equivalent is required for measuring the angles in the following steps. Protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0° and the 90° marks will be used. It should be kept in mind that these are reference marks only and the actual numbers should be ignored. (Figure 4) It is only necessary to note the number of degrees and to which side (left or right) of the reference marks the indicator needle rests. PROTRACTOR MUST BE VIEWED FROM THE SAME SIDE OF POWER PACKAGE THROUGHOUT ALIGNMENT.

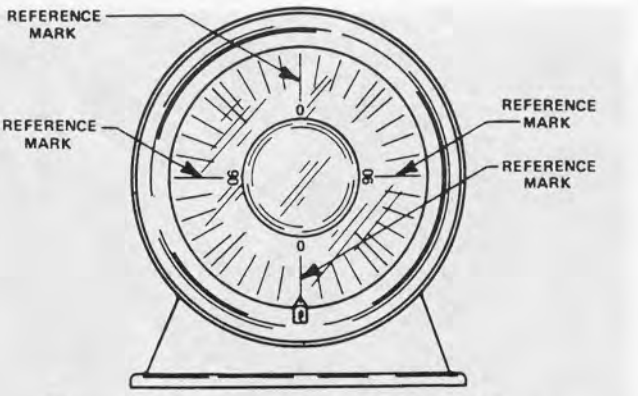


Figure 4. Protractor Reference Marks

1. Insert solid end of alignment tool thru bearing in gimbal housing and into bearing support input shaft splines. (Figure 3)
2. Position base of protractor against input shaft flange, as shown in Figure 5. NOTE and RECORD the number of degrees and to which side of the reference mark the indicator needle has moved in the chart following.

READING from STEP 2
_____ degrees to the
_____ side of Reference mark.

IMPORTANT: Be sure that boat does not move once reading has been taken from input shaft flange, as this reading establishes reference point for aligning drive shaft and engine following.

3. Lift engine into boat, using an overhead hoist and a chain (attached to lifting eyes on engine).

⚠CAUTION

When attaching drive shaft in next step. BE SURE that the pilot on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges MUST BE flush to each other prior to tightening screws, or screws may come loose during operation.

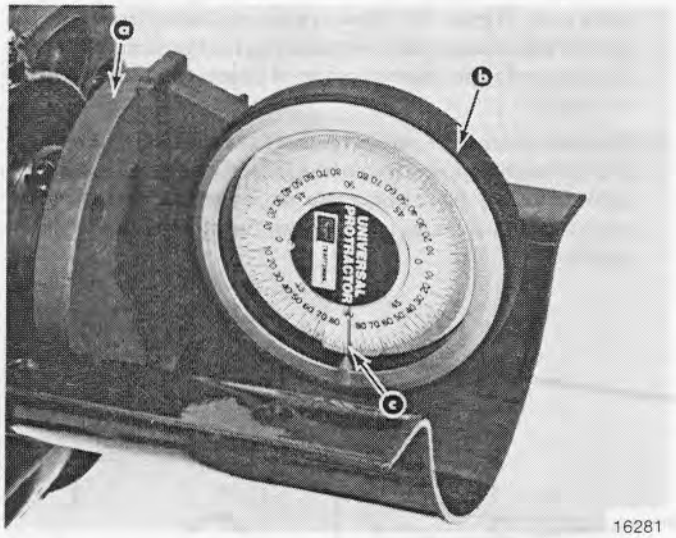
4. Attaching drive shaft to input shaft flange and output shaft flange, as shown in Figures 6 and 7.
5. Position base of protractor on drive shaft (Figure 8); then, adjust engine mounts so that indicator needle is 1° to 3° on either side of reading taken in Step 2. Record this reading in the following chart for later use.

READING from STEP 5

_____ degrees to the

_____ side of Reference mark.

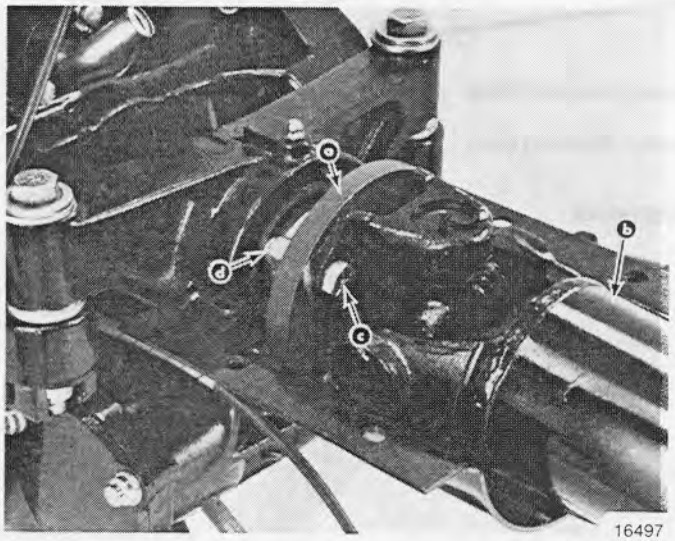
IMPORTANT: A minimum of ¼" (6mm) up-and-down engine mount adjustment must exist after engine has been properly aligned. This is necessary to allow for realignment of the engine in the future. If mount travel is insufficient, boat stringer height MUST BE adjusted.



16281

a - Input Shaft Flange
b - Protractor
c - Indicator Needle

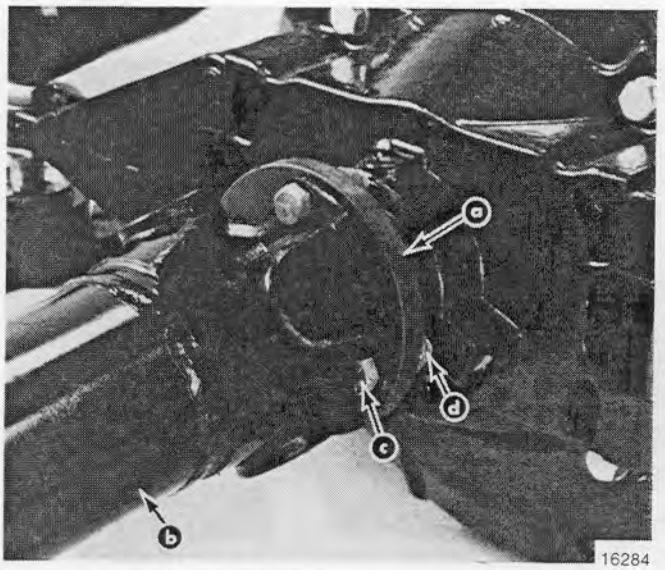
Figure 5. Measuring Angle of Input Shaft Flange



16497

a - Input Shaft Flange
b - Drive Shaft
c - Screw (4 Used) (Torque to Specifications)
d - Nut (4 Used)

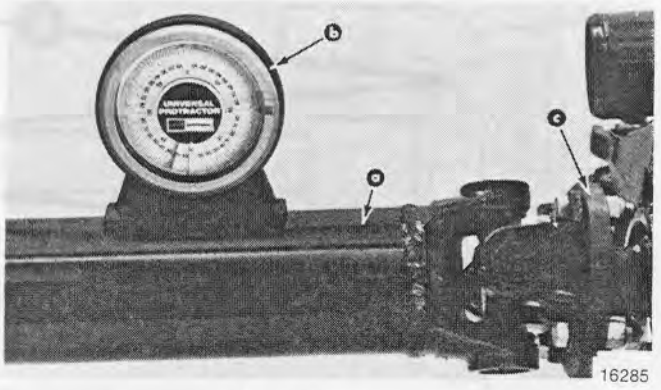
Figure 6. Drive Shaft Attached to Input Shaft Flange



16284

a - Output Shaft Flange
b - Drive Shaft
c - Screw (4 Used) (Torque to Specifications)
d - Nut (4 Used)

Figure 7. Drive Shaft Attached to Output Shaft Flange



16285

a - Drive Shaft
b - Protractor
c - Output Shaft Flange

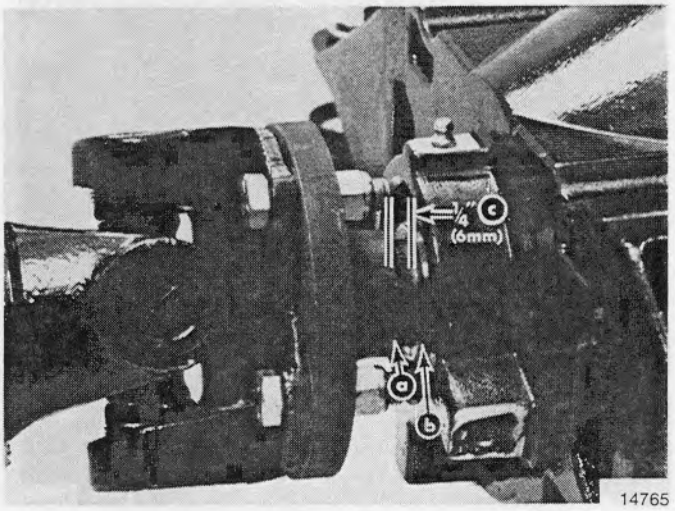
Figure 8. Measuring Drive Shaft Angle

IMPORTANT: Failure to properly position engine (as described following) may result in bearing damage.

6. Relieve hoist tension from engine, then slide engine fore or aft as needed to obtain a ¼" (6mm) between flange shoulder and extension shaft housing bearing, as shown in Figure 9.

⚠CAUTION

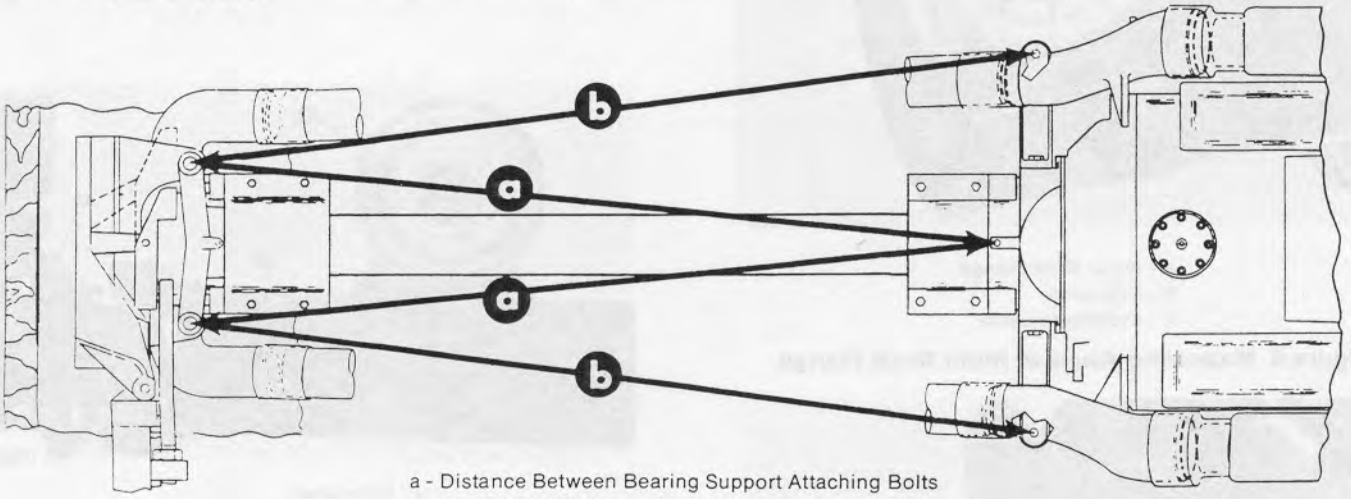
Engine MUST BE aligned correctly to achieve proper engine operation and to prevent damage to drive shaft. If drive shaft is run at an incorrect angle, damage to universal joint bearings may result.



a - Flange Shoulder
b - Bearing
c - 1/4" (6mm)

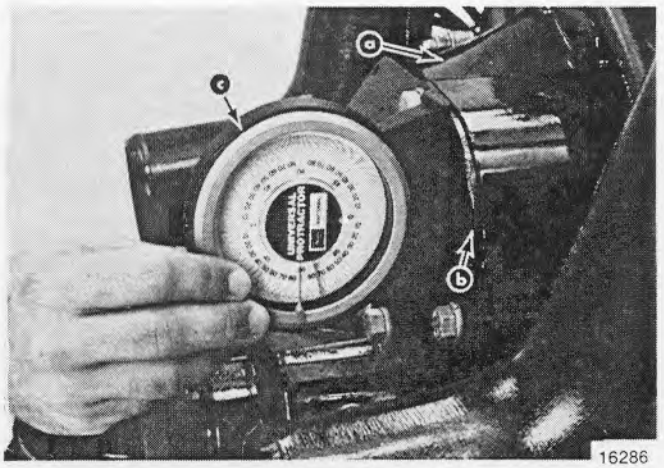
Figure 9. Distance Between Output Shaft Shoulder and Bearing

7. Position engine for correct engine and drive shaft lateral alignment as follows:
   a. The distance between the center of the bearing support attaching bolts (on inner transom plate) and grease fitting on shaft extension housing (Figure 10) MUST BE equal. If not, slide aft end of engine to one side or the other until distances are equal.
   b. Measure distance between the center of the bearing support attaching bolts and rear engine mount adjusting bolt, as shown in Figure 10. These distances also, MUST BE equal. If not, slide front of engine to one side or the other until distances are equal.
8. After engine has been aligned correctly, fasten front and rear engine mounts to stringers.
9. Position protractor on starter housing cover plate, as shown in Figure 11. Now, raise or lower front engine mount adjusting nuts as required so that protractor needle reads exactly the same number of degrees as that recorded in Step 2.
10. Position protractor on drive shaft (as shown in Figure 8) and recheck angle. Angle should be the same as that recorded in Step 5. If not, raise or lower all engine mount adjusting nuts an equal amount until correct angle is reached.



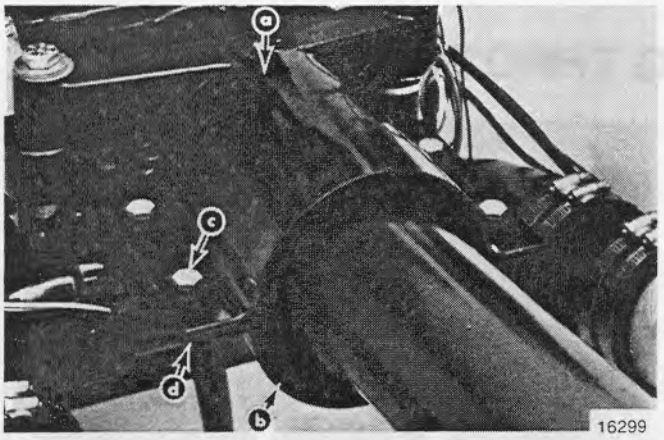
a - Distance Between Bearing Support Attaching Bolts and Grease Fitting
b - Distance Between Bearing Support Attaching Bolts and Engine Mount Bolts

Figure 10. Engine Alignment



a - Flywheel Housing
b - Starter Housing Cover Plate
c - Protractor

Figure 11. Protractor Positioned Correctly on Starter Housing Cover Plate

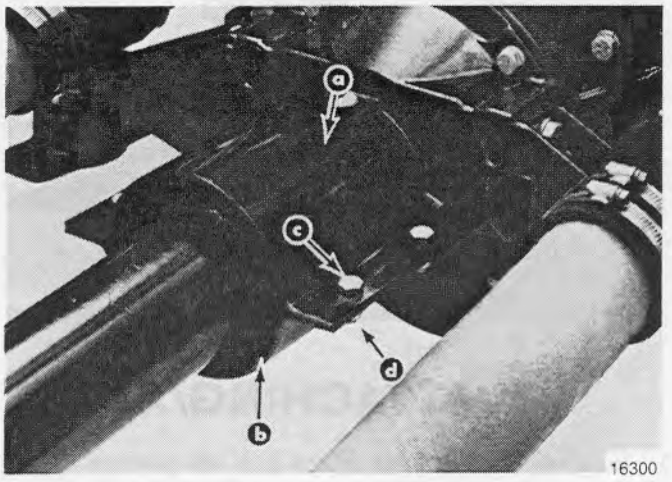


a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used) (Torque to Specifications)

Figure 12. Top Shield Attached to Bottom Shield at Transom End

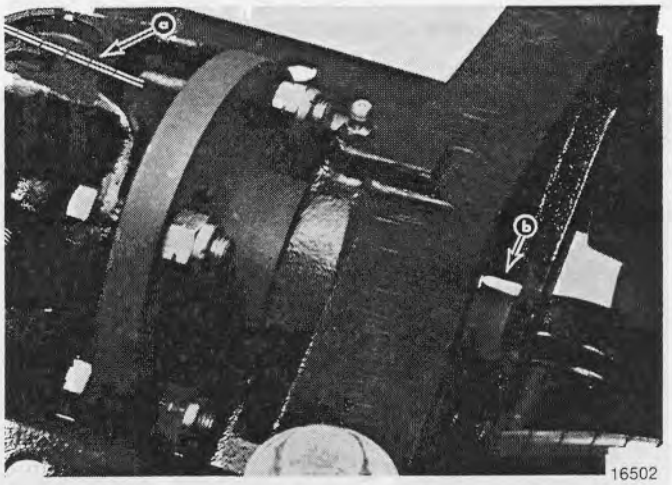
11. Tighten ALL engine mount locking nuts securely.
12. Remove alignment shaft from gimbal housing.
13. Install drive shaft shields. (Figures 12 and 13)

14. Install stern drive unit. Stern drive unit installation procedure is the same as that for the standard models, with the following exceptions:
    - No alignment is necessary, other than to align gimbal bearing with bearing support input shaft. Steps 2 and 3.
    - Stern drive universal joints MUST BE aligned with drive shaft universal joints, as shown in Figures 14 and 15. Place a reference mark (white paint) on shafts to correspond with universal joint centerlines. After installing stern drive, check to ensure that these marks are in alignment.



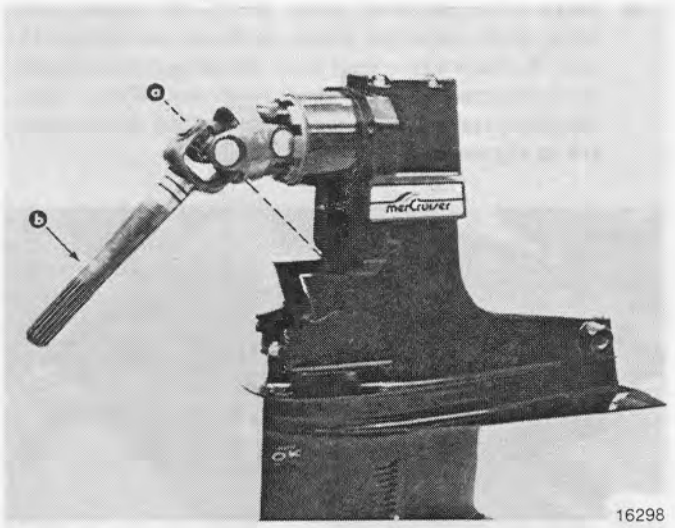
a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used) (Torque to Specifications)

Figure 13. Top Shield Attached to Bottom Shield at Engine End



a - Imaginary Centerline Running Thru This Universal Joint Bearing Must Be Vertical
b - Place a Reference Mark Here To Correspond with "a"

Figure 14. Aligning Drive Shaft Universal Joint

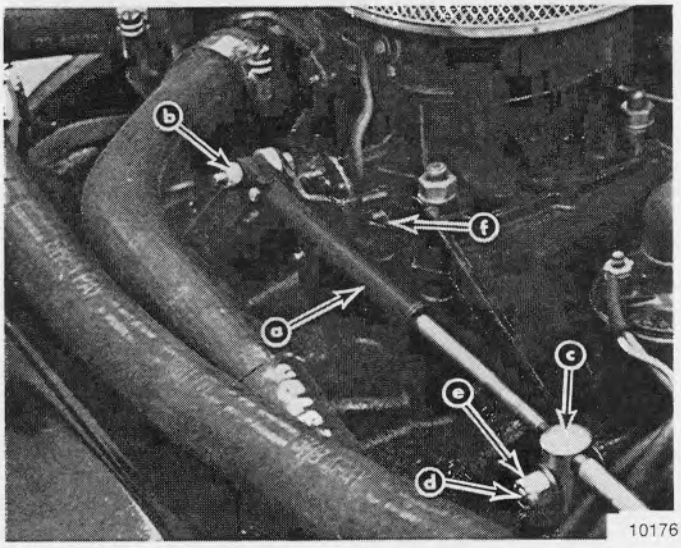


a - Imaginary Centerline Running Thru This Universal Joint Bearing Must Be Vertical (Once Drive Unit Is Installed)
b - Place a Reference Mark Here To Correspond with "a"

Figure 15. Aligning Stern Drive Unit Universal Joints

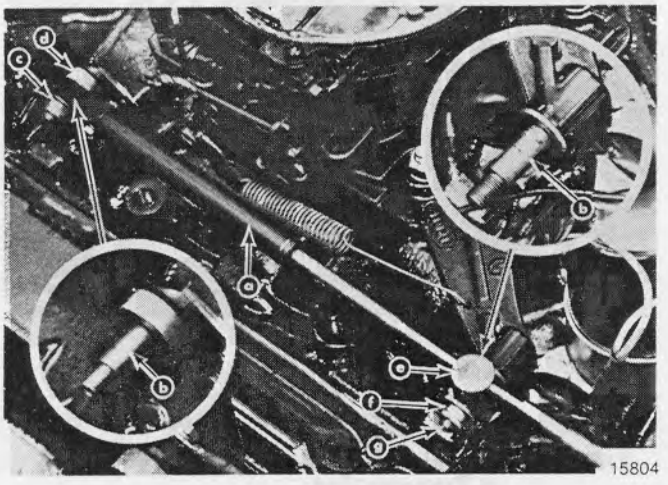
ATTACHING/ADJUSTING THROTTLE CABLE

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown in Figure 1 or 2.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown in Figure 1 or 2.
4. Check that throttle valves are fully open when remote control is at full throttle position. Lever tang should be against stop as shown in Figure 3 or 4.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop. (Figure 1 or 4)



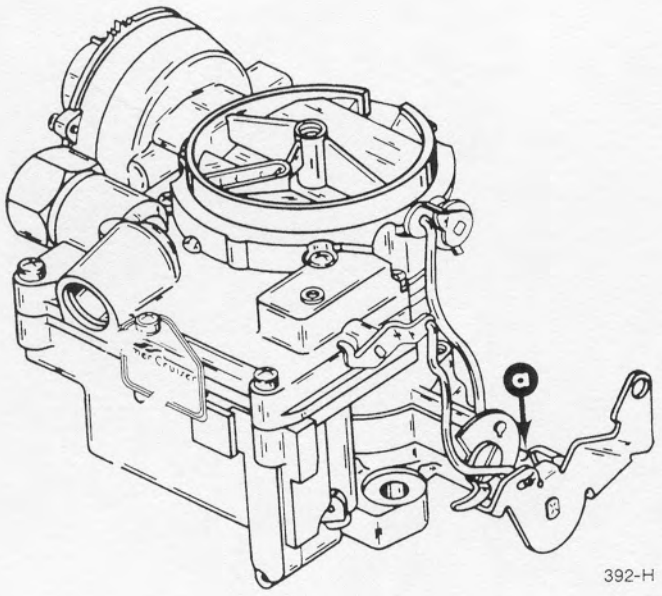
a - Cable End Guide
b - Washer, Nut, Screw and Bushing (DO NOT Over-Tighten)
c - Brass Barrel
d - Stud
e - Washer and Nut (DO NOT Over-Tighten)
f - Idle Stop Screw

Figure 1. MCM 898/898R



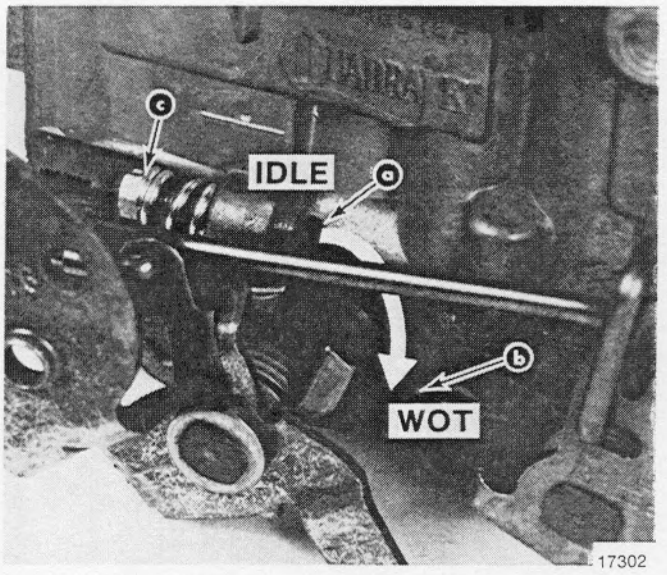
a - Cable End Guide
b - Bushing
c - Washer, Nut and Screw (DO NOT Over-Tighten)
d - Spacer
e - Brass Barrel
f - Washer and Nut (DO NOT Over-Tighten)
g - Anchor Stud

Figure 2. MCM 228/228R/260/260R



a - Throttle Lever Tang Against Stop

Figure 3. MCM 898/898R

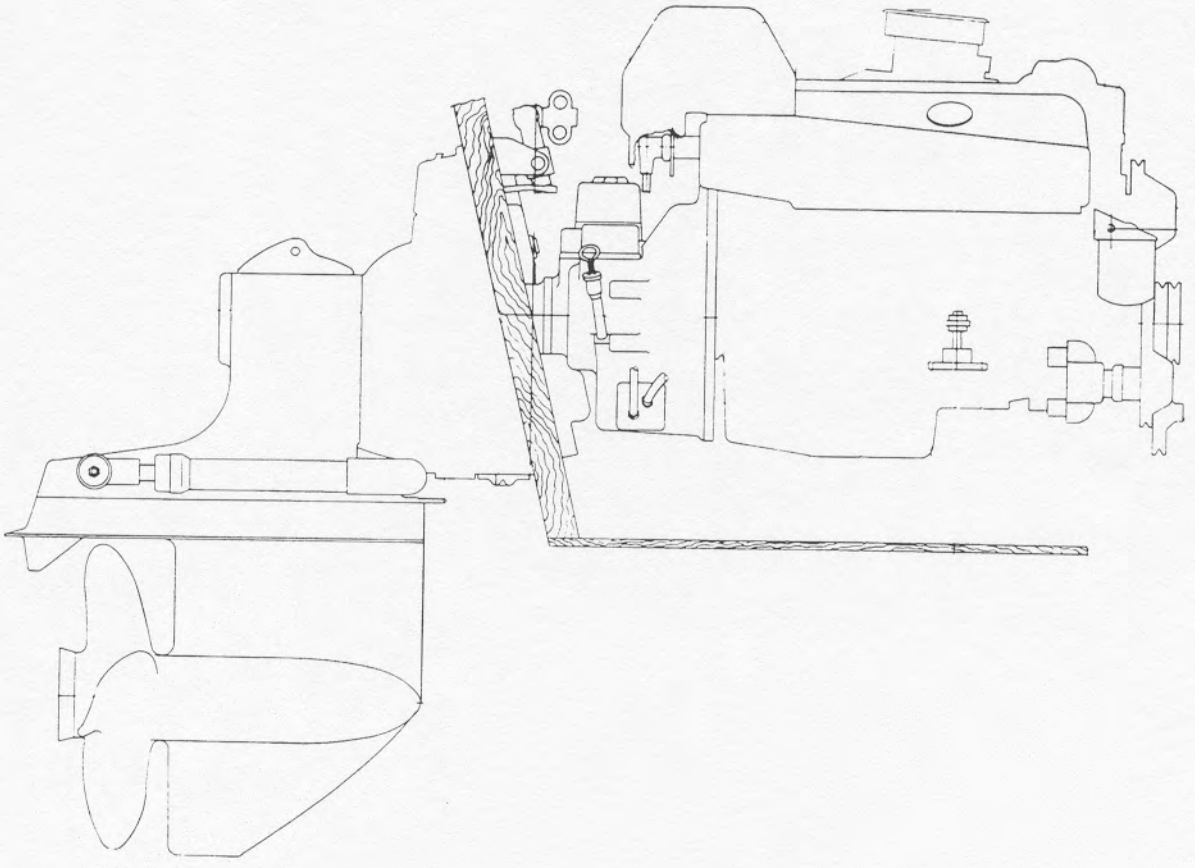


a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

Figure 4. MCM 228/228R/260/260R

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART F - MCM 330TR/TRS WITH MERCURY MARINE TRANSMISSION



MERCURY MARINE
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STERN DRIVES & INBOARDS

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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Front Engine Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings Large	20-25 (27-34)	
Small		96-108 (11-12)
Rear Engine Mount Compression Nuts		70 (8)
Remote Control Shift Cable Brass Barrel		60-70 (7-8)
Cable End Guide		60-70 (7-8)
Remote Control Throttle Cable Brass Barrel	Securely	
Cable End Guide	(Note 1)	

NOTE 1: Tight, then back nut off 1/2 turn.

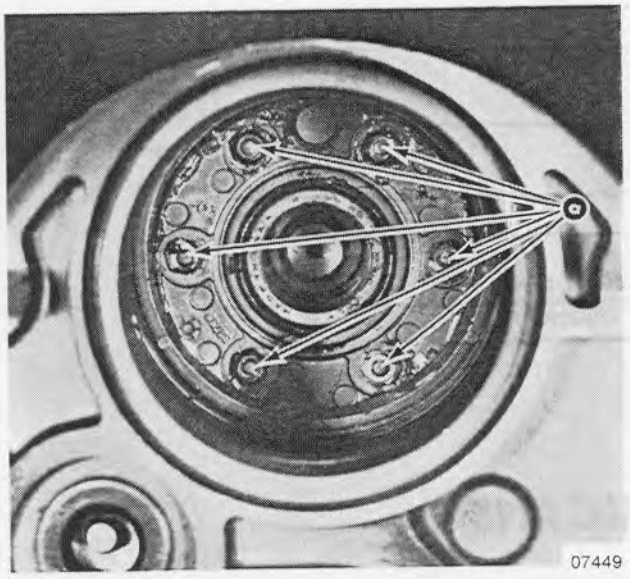
TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Multi-Lube

REMOVAL

NOTICE
Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual."

1. Loosen 6 transmission output housing rear mount nuts. (Figure 1)



a - Nuts (6)

Figure 1. Rear Mounting Nuts

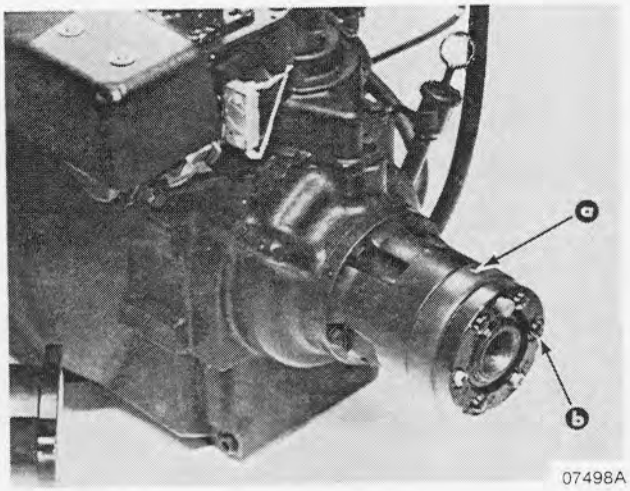
2. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
3. Disconnect fuel line and throttle cable.
4. **Electric Shift Models:** Remove electric shift wiring harness from terminal block (located on transmission).
   Mechanical Shift Models: Remove shift cable.
5. Remove red and black Power Trim pump motor wires from engine (some models).
6. Disconnect water inlet hose and exhaust elbow bellows.
7. Disconnect fluid hoses from power steering control valve.
8. Remove Power Trim hoses from reverse lock located on transmission (some models).
9. Disconnect trim position sender wires from terminal block located on engine.
10. Disconnect any grounding wire or accessories that are connected to the engine.

IMPORTANT: DO NOT lift engine until rear mount is disengaged from gimbal housing.

11. Support engine with a suitable sling thru lifting eyes on engine and remove engine front mounting bolts.
12. Pull engine forward to disengage rear engine mount from gimbal housing and carefully remove engine.

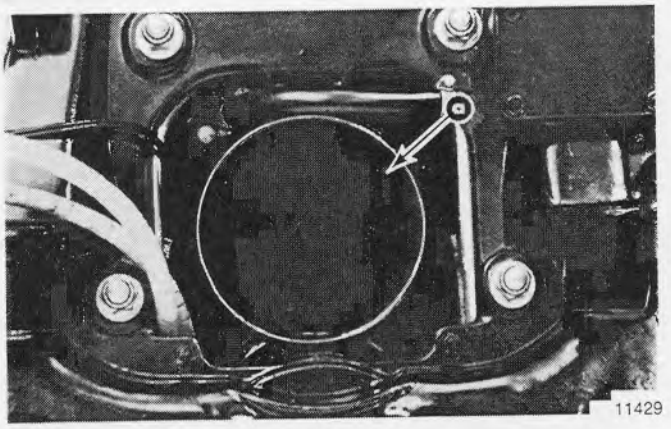
INSTALLATION/ALIGNMENT

1. Coat rubber rear mount (Figure 1) and gimbal housing opening (Figure 2) with 2-4-C Multi-Lube.



a - 2-4-C Multi-Lube
b - Nuts (6)

Figure 1. Rubber Rear Mount



a - 2-4-C Multi-Lube

Figure 2. Gimbal Housing Opening

IMPORTANT: Make sure that 6 nuts on transmission output housing are loose before installing. (Figure 1)

2. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
3. Position engine ahead of inner transom plate so that transmission output housing (Figure 1) is in line with large opening in inner transom plate. (Figure 2)
4. Move engine toward inner transom plate and, at the same time, guide transmission output housing into gimbal housing opening until output housing bottoms-out on shoulder in gimbal housing. Be careful that transmission output housing and rubber mount do not become damaged.

⚠CAUTION

Transmission output housing MUST BOTTOM-OUT on SHOULDER in gimbal housing or exhaust elbow misalignment will result, with subsequent damage to exhaust system.

5. Relieve hoist tension, as required, to allow transmission output housing to seat in gimbal housing.

IMPORTANT: Do not relieve hoist tension entirely at this time, as transmission and output housing may be damaged.

6. Position alignment tool plate on shaft, as shown in Figure 3. Thread extension onto alignment shaft, insert end of alignment tool into opening in bell housing and into transmission output housing. (Figure 3) Insert shaft until it bottoms-out in transmission output housing.

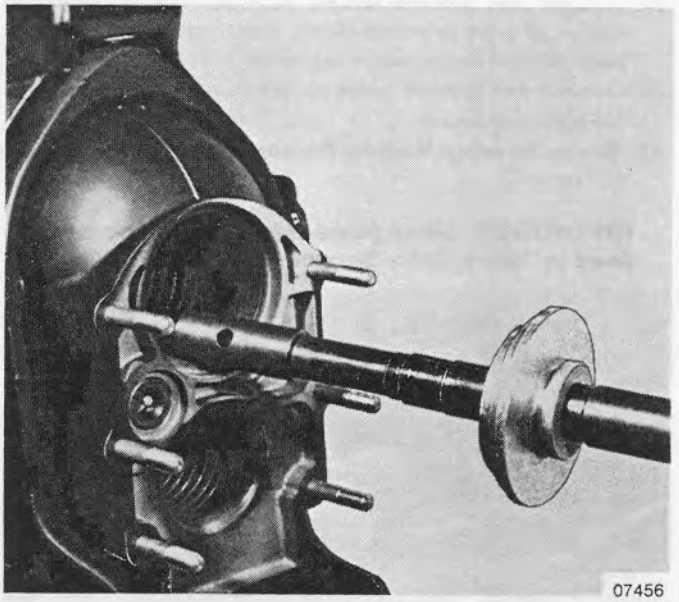


Figure 3. Alignment Tool Location

7. Slide plate toward bell housing. Raise or lower front of engine with hoist to allow shoulder on plate to enter bell housing opening. (Figure 4)

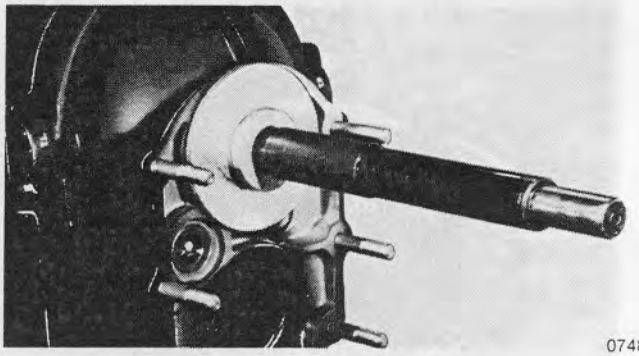


Figure 4. Tool Plate Installed

8. With alignment tool plate positioned in bell housing and engine supported with hoist, front engine mount supports should be constructed so that mounts will rest on top of supports without disturbing alignment tool plate position when hoist tension is relieved.

IMPORTANT: Engine alignment should be near to correct before front engine mounts are fastened to engine bed. Only small adjustment should be necessary in following procedure.

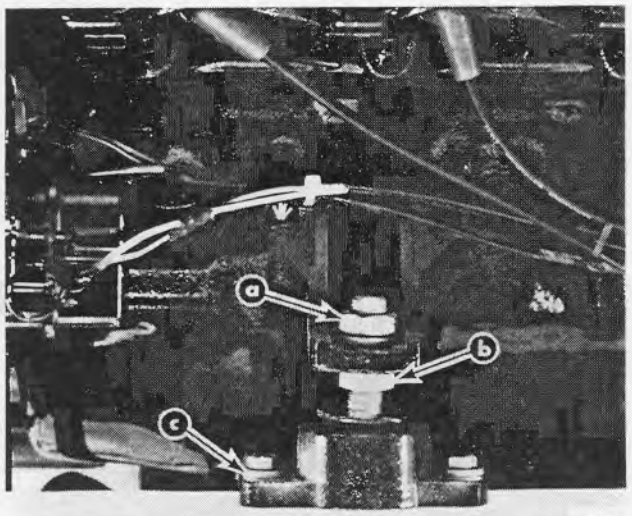
9. Relieve hoist tension entirely and fasten front mounts (with slotted mounting hole toward front of engine) to engine bed.

IMPORTANT: Steering link rod must be disconnected before proceeding with engine alignment. Reconnect after alignment is completed.

10. Push alignment shaft and plate toward engine and, while holding plate against bell housing, check for gap between plate and rear surface of bell housing at 12, 3, 6 and 9 o'clock positions. Engine alignment is correct when there is no gap at any point. If gap exists, proceed as follows:

GAP AT 12 O'CLOCK POSITION

Raise front of engine. Loosen locking nuts (Figure 5) and turn adjusting nuts counterclockwise. Turn adjusting nuts (on both front mounts) an equal amount by alternating from one side to the other until gap no longer exists. Retighten locking nuts securely.



a - Locking Nut
b - Adjusting Nut
c - Slotted Hole

Figure 5. Front Engine Mounts

GAP AT 6 O'CLOCK POSITION

Lower front of engine. Loosen locking nuts (Figure 5) and turn adjusting nuts clockwise. Turn adjusting nuts (on both front mounts) an equal amount by alternating from one side to the other until gap no longer exists. Retighten locking nuts securely.

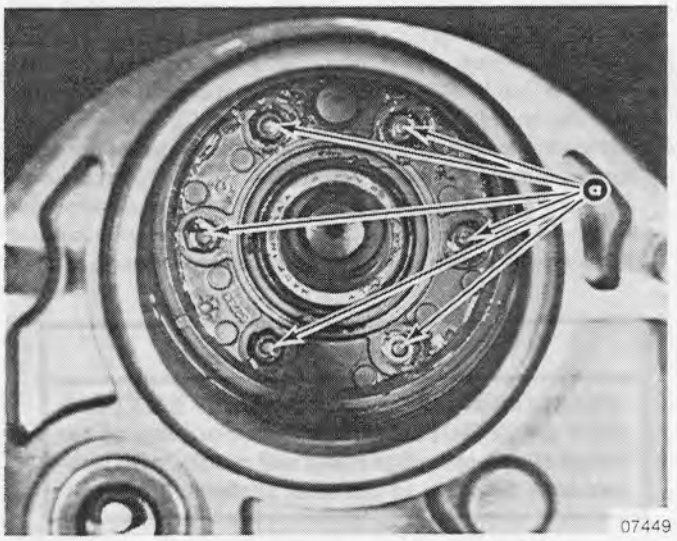
GAP AT 3 O'CLOCK POSITION

Loosen lag screws which attach mounts to engine bed. Move engine to the right (starboard), using adjustment slot (Figure 5), until gap no longer exists. Retighten engine mount to engine bed lag screws securely.

GAP AT 9 O'CLOCK POSITION

Loosen lag screws which attach mounts to engine bed. Move engine to the left (port), using adjustment slot (Figure 5), until gap no longer exists. Retighten engine mount to engine bed lag screws securely.

11. After correct alignment has been attained, re-check all mount fasteners to be sure that they are tight.
12. Remove alignment shaft and plate. (Shaft should remove easily.)
13. Torque 6 rear mount compression stud nuts to specifications. (Figure 6)

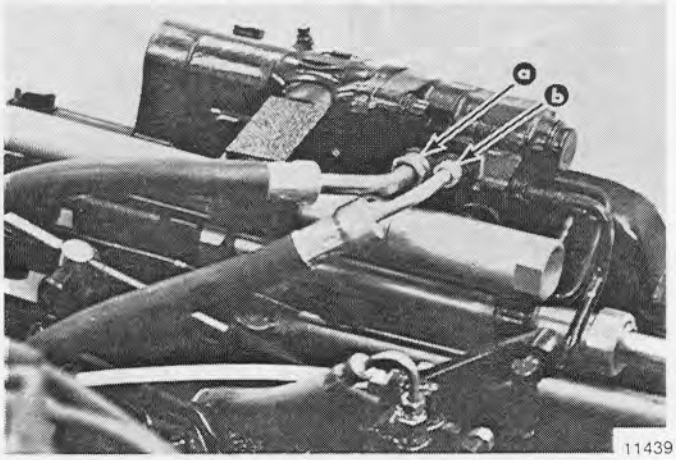


a - Compression Nuts (6) - Torque to Specification

Figure 6. Rear Engine Mount

14. Retighten bellows clamps on exhaust manifold elbows (both sides).
15. Connect water inlet hose to seawater pump. Tighten clamp securely.
16. Connect instrument harness to engine harness. Secure with clamp and tighten securely.
17. Connect red and black Power Trim pump wires to engine (some models).
18. Connect fuel line. Check for leaks.
19. Connect trim position sender wires to terminal block on engine. (Purple or brown sleeve wire to insulated terminal, black wire to block mounting screw.)
20. Connect any ground wires or accessories that may have been disconnected.
21. **Power Steering Models:** Reconnect fluid hoses as shown in Figure 7.

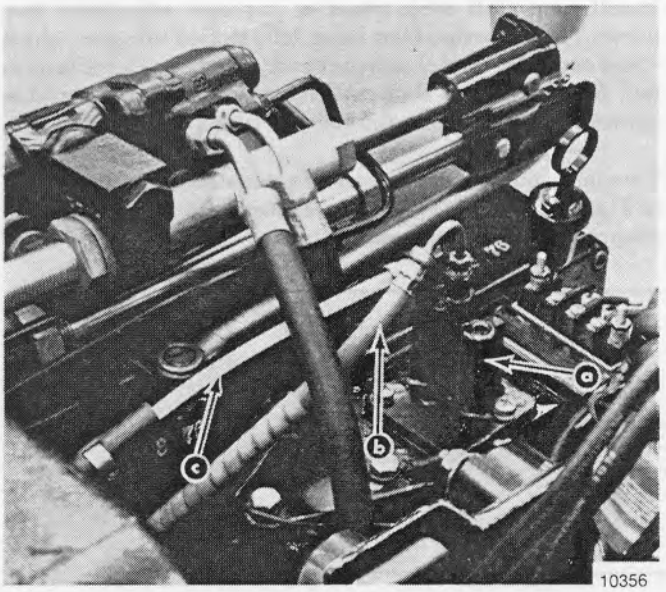
IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".



a - Large Fitting
b - Small Fitting
Torque to Specifications

Figure 7. Power Steering Connections

22. Connect Power Trim hoses to reverse lock valve as shown in Figure 8. (Some models.)



a - Reverse Lock
b - Gray Hose from Transom Plate
c - Plastic Hose from Trim Pump

Figure 8. Reverse Lock Connections

23. For shift and throttle connections, refer to the following:
    - "Attaching Electric Shift Control"
    - "Attaching/Adjusting Mechanical Shift Cable"
    - "Attaching/Adjusting Throttle Cable"
24. Connect battery cables to battery.

ATTACHING ELECTRIC SHIFT CONTROL

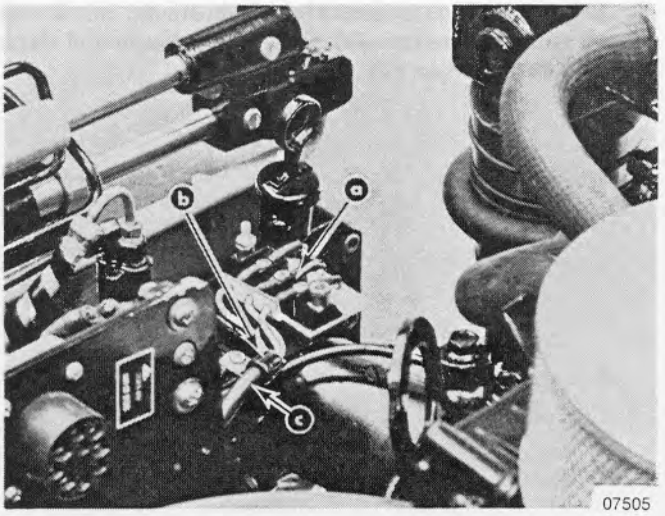
IMPORTANT: Battery cables must be disconnected from battery prior to connecting shift control wiring to shift motor.

1. Remove shift motor cover.

⚠CAUTION

Shift harness wires are color-coded and MUST BE attached to terminals of same color on shift motor terminal block. If not connected correctly, transmission failure will occur. (Figure 2)

2. Connect ring terminals (located on shift control harness) to terminals on shift motor, matching lead and terminal colors. Fasten harness clamp to shift motor bracket. (Figure 1) Reinstall cover.



a - Terminal Block
b - Harness Clamp
c - Remote Control Harness

Figure 1. Harness Connection

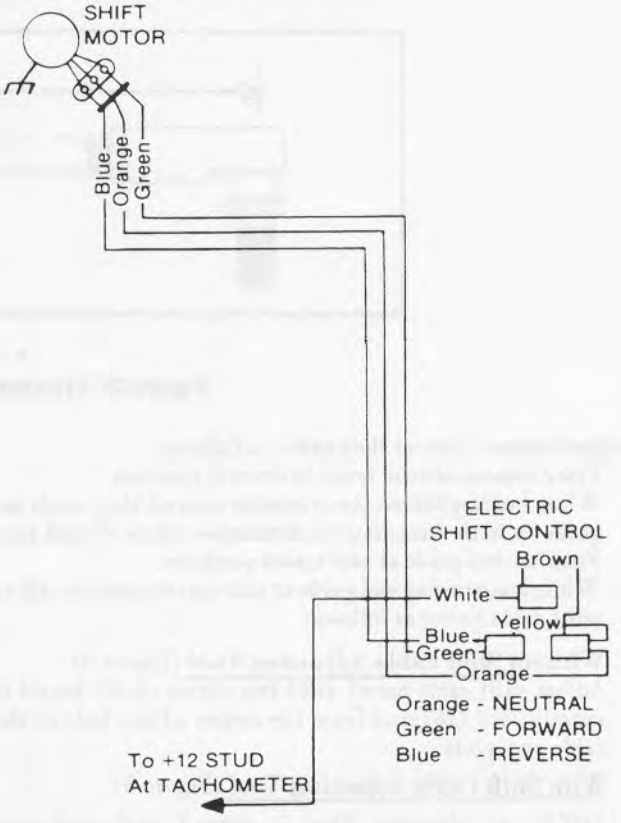


Figure 2.

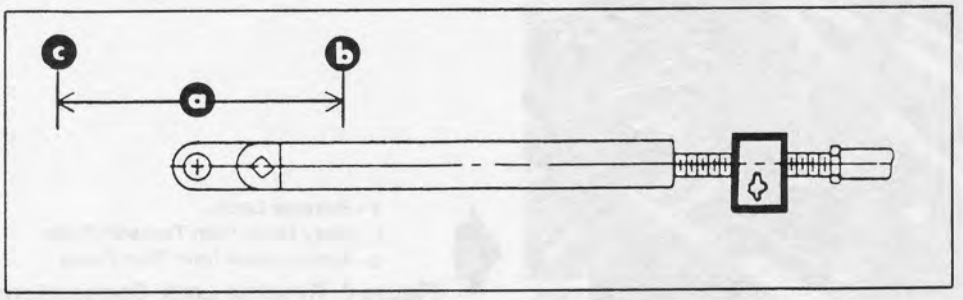
ATTACHING/ADJUSTING MECHANICAL SHIFT CABLE

⚠CAUTION

Remote control shift cable end guide must retract when remote control is shifted into forward gear or transmission failure will occur. (Figure 1)

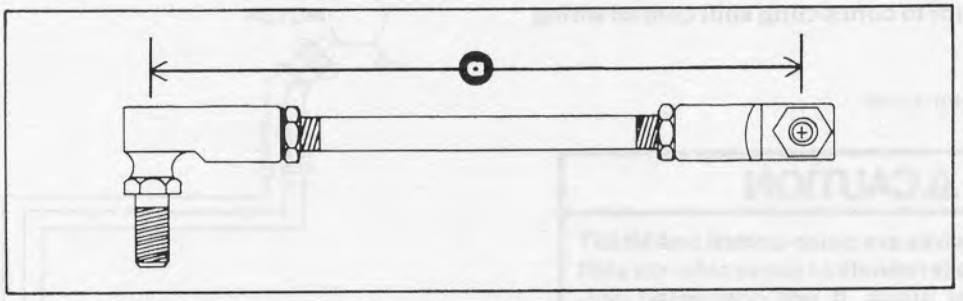
Insufficient shift cable travel or improper adjustment may prevent transmission from being fully shifted into gear, which could cause forward clutch pack and/or reverse clutch band to fail. Remote control shift cable must have minimum travel as shown in Figure 1 from full forward to full reverse.

Transmission shift rod assembly is preset to dimension shown in Figure 2 and MUST NOT be changed. Check dimension to ensure that it has not been changed.



a - 2-13/16" (72mm) Minimum, 3" (76mm) Ideal
b - Forward Gear
c - Reverse Gear

Figure 1. Shift Cable Travel



a - 5-1/32" (128mm)

Figure 2. Transmission Shift Rod Dimension

Adjust Remote Control shift cable as follows:

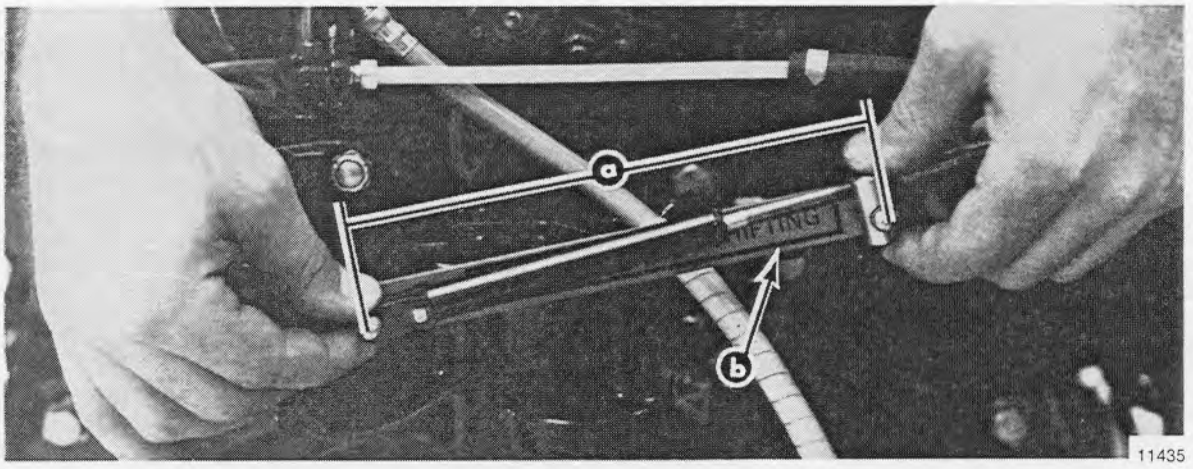
1. Place remote control lever in neutral position.
2. While holding barrel, move remote control shift cable end guide in both directions to determine limits of end play. Position end guide at mid-travel position.
3. While maintaining end guide at mid-travel position, adjust shift cable barrel as follows:

   Without Shift Cable Adjusting Tool (Figure 3):
   Adjust shift cable barrel until the center of the barrel is exactly 7⅛" (181mm) from the center of the hole in the cable end guide.

   With Shift Cable Adjusting Tool (Figure 3):

   NOTE: An Adjusting Tool is shipped with each new MerCruiser TR, TRS Power Package and Mechanical Shift Conversion Kit and is given to the boat owner after initial installation. Obtain tool from boat owner to perform the following adjustment. This tool is not available from our Service Department.

   a. Place Adjusting Tool on studs and reinstall spacer on anchor stud.
   b. Adjust shift cable barrel to align attaching holes with studs.
   c. Remove Adjusting Tool from studs.
4. Being careful not to disturb barrel adjustment, install cable on studs and secure with flat washer, spacer and elastic stop nuts. Torque nuts to specifications.

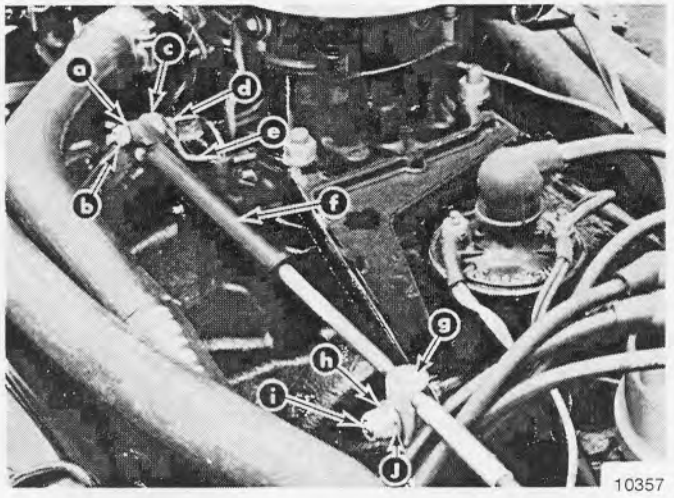


a - 7-1/8" (181mm)
b - Shift Adjustment Tool

Figure 3. Adjusting Shift Cable Barrel

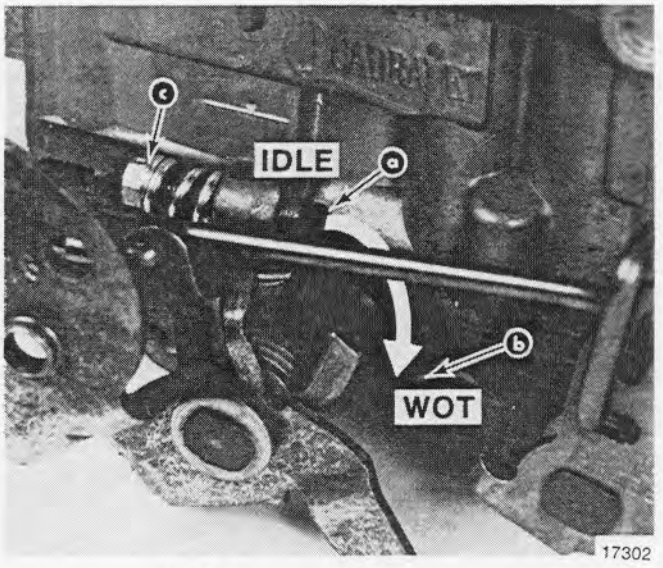
ATTACHING/ADJUSTING THROTTLE CABLE

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown in Figure 1.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown in Figure 1.



a - Bushing (Hidden)
b - Nut and Washer (DO NOT Over-Tighten)
c - Spacer
d - Screw
e - Throttle Lever
f - Cable End Guide
g - Brass Barrel
h - Nut and Washer (DO NOT Over-Tighten)
i - Anchor Stud
j - Spacer (Hidden)

Figure 1. Throttle Cable Installed



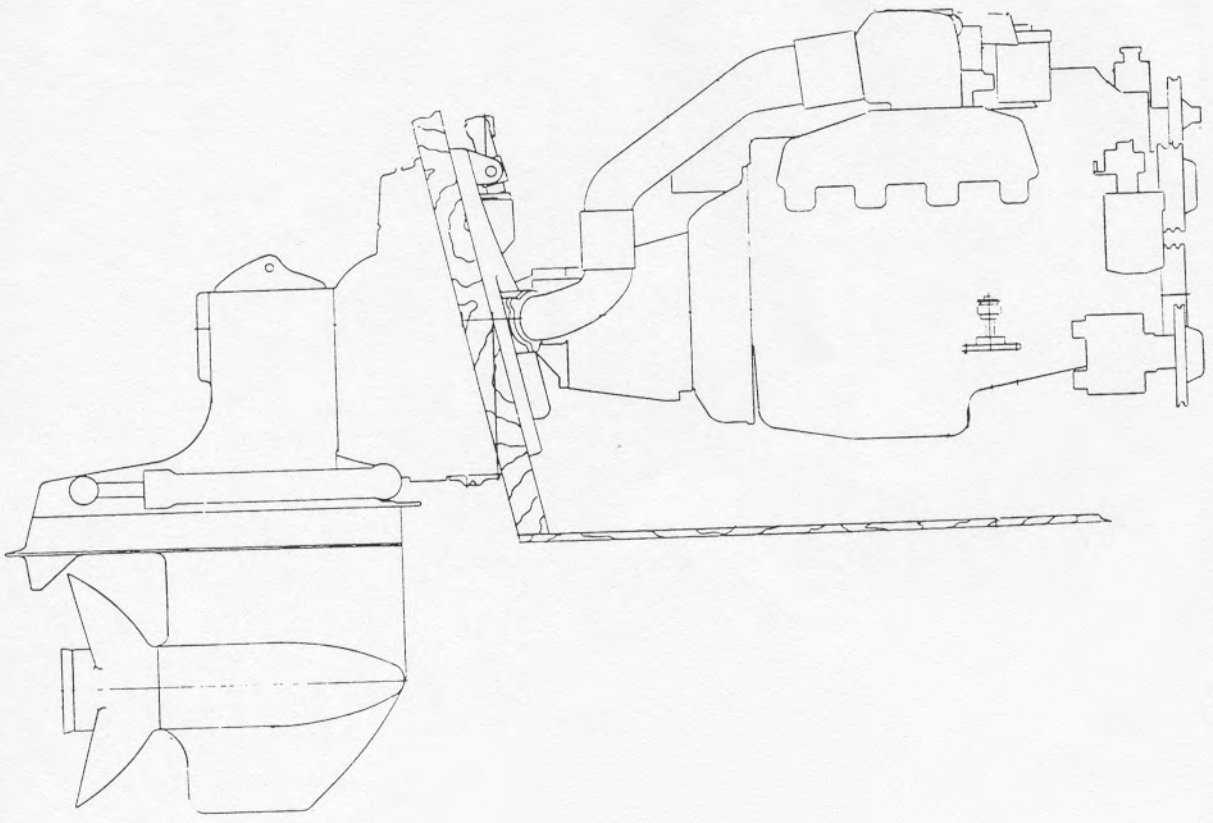
a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

Figure 2. Idle/Full Throttle Check

4. Check that throttle valves are fully open when remote control is in full throttle position. (Figure 2)
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop. (Figure 2)

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART G - MCM 330 (B-W) TR/TRS



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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Front Engine Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings		
Large	20-25 (27-34)	
Small		96-108 (11-12)
Rear Engine Mount	100 (136)	
Remote Control Shift Cable		
Brass Barrel	(Note 1)	
Cable End Guide	(Note 1)	
Remote Control Throttle Cable		
Brass Barrel	(Note 1)	
Cable End Guide	(Note 1)	

NOTE 1: Tight, then back nut off 1/2 turn.

TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Multi-Lube

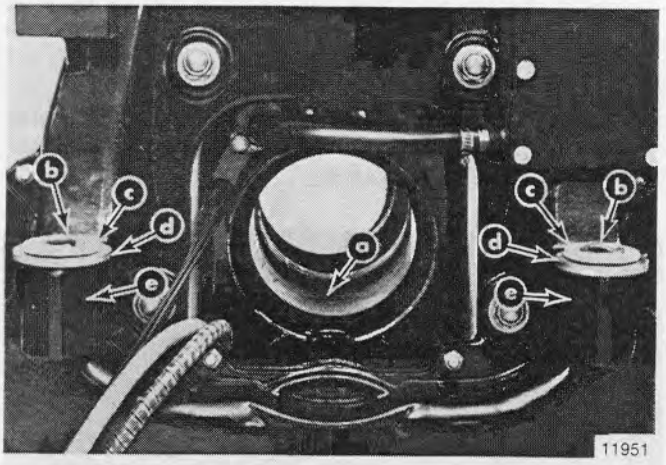
REMOVAL

NOTICE
Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual."

1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Disconnect trim position sender wires from terminal block on flywheel housing.
4. Disconnect water inlet hose and exhaust elbow bellows.
5. Remove shift cable.
6. Remove buzzer tan/blue wire from water heat switch in thermostat housing.
7. Disconnect any grounding wire or accessories that are connected to the engine.
8. **Power Steering Models:** Disconnect fluid hoses from power steering control valve.
9. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
10. Pull engine forward to disengage transmission output housing from gimbal housing and carefully remove engine.

INSTALLATION/ALIGNMENT

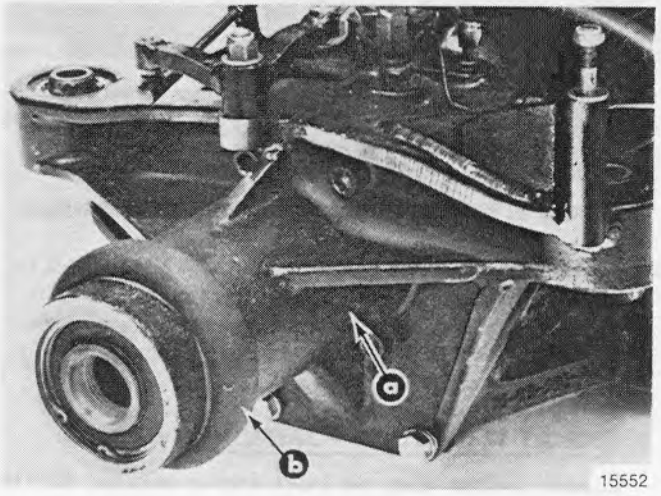
1. Prepare transom assembly as shown in Figure 1.



a - Transom Gimbal Housing Assembly Opening (Lubricate with 2-4-C Multi-Lube)
b - Double-Wound Lockwasher (2)
c - Fiber Washer (2)
d - Large Steel Washer (2)
e - Engine Supports

Figure 1. Preparing Transom Assembly

2. Prepare transmission output housing as shown in Figure 2.



a - Transmission Output Housing
b - "O" Ring Seal (Lubricate with 2-4-C Multi-Lube)

Figure 2. Transmission Output Housing

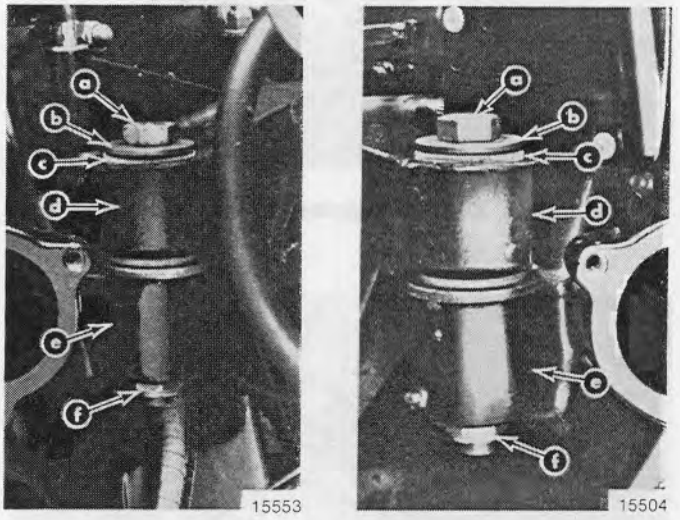
3. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine.
4. Position engine ahead of inner transom plate so that transmission output housing (Figure 2) is in line with large opening in inner transom plate. (Figure 1)

IMPORTANT: Take care when installing engine in next step to prevent damage to "O" ring seal on transmission output housing.

5. Carefully guide transmission output housing into transom gimbal housing assembly until holes in rear engine mounts align with holes in inner transom plate engine supports.

IMPORTANT: DO NOT relieve hoist tension entirely, as inner transom plate engine supports and/or transmission output housing may be damaged.

6. Relieve hoist tension, as required, to allow rear engine mounts to rest on inner transom plate engine supports and washers.
7. Secure rear engine mounts as shown in Figure 3. Torque bolts to specifications.



a - Bolt
b - Steel Washer
c - Fiber Washer
d - Rear Engine Mount
e - Inner Transom Plate Engine Support
f - Elastic Stop Nut

Figure 3. Securing Starboard and Port Rear Engine Mounts

8. Insert solid end of Alignment Tool thru bell housing bore and into transmission output housing until it bottoms. (Figure 4) Slide plate toward bell housing and position bell housing, as required, to allow shoulder on plate to enter bell housing bore. (Figure 5)

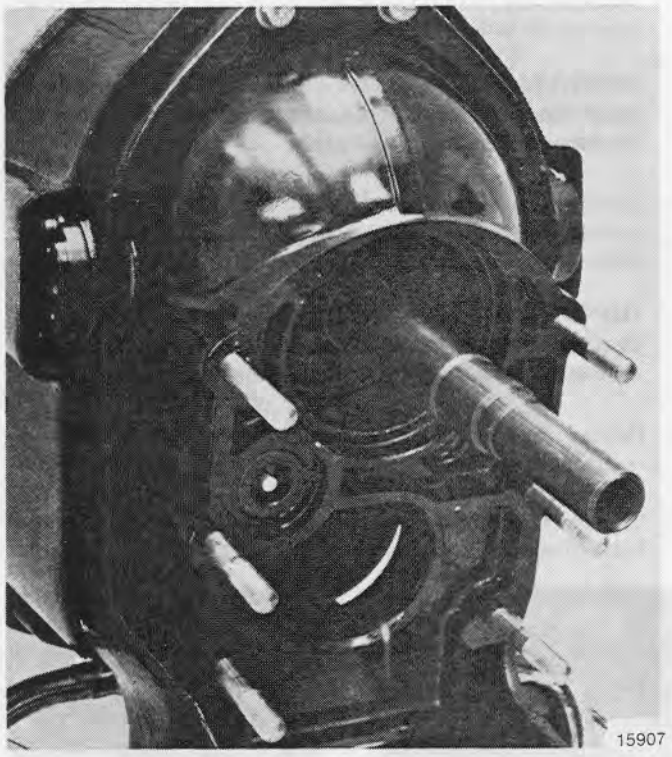


Figure 4. Engine Alignment Tool Installed

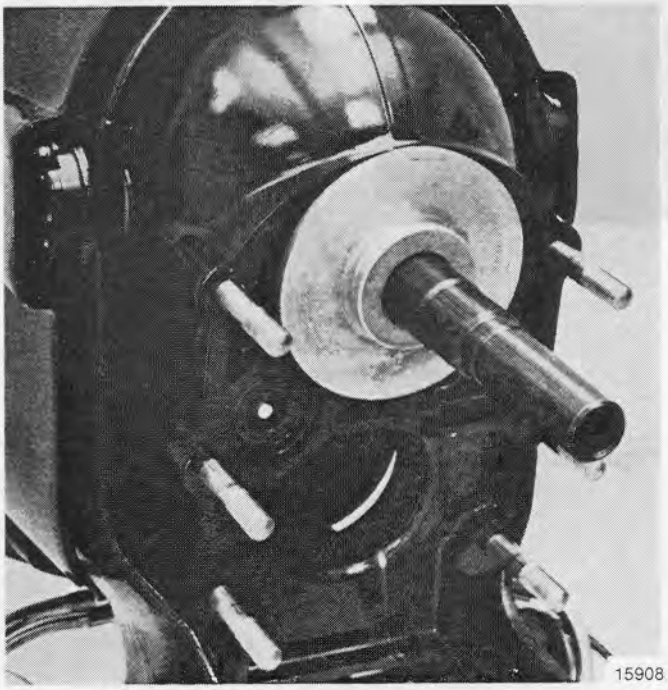
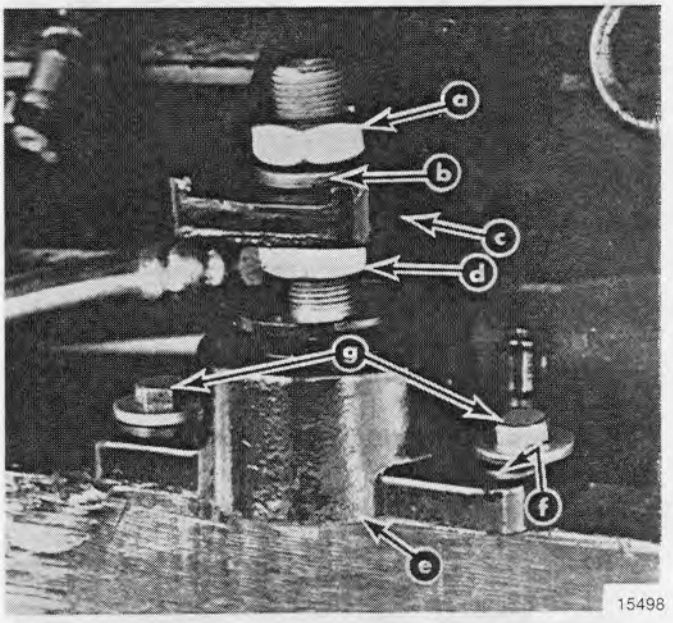


Figure 5. Engine Alignment Tool Plate in Position

9. With alignment tool plate positioned in bell housing and engine supported with hoist, front engine mounts should rest on top of stringers without disturbing alignment tool plate position when hoist tension is relieved.

   NOTE: Boat stringers must position engine so that a minimum of ¼" (6mm) of up-and-down front mount adjustment exists after mounts are lowered onto stringers.

10. Relieve hoist tension entirely and fasten front engine mounts (with slotted mounting hole toward front of engine) to stringers. (Figure 6)



a - Locking Nut
b - Lockwasher
c - Front Mount Bracket
d - Adjusting Nut
e - Front Mount
f - Slot (Must Be Forward)
g - Lag Bolts

Figure 6. Engine Mount Secured to Boat Stringer

11. While pushing in on alignment shaft and plate, check for gap between plate and bell housing rear surface at 12, 6, 3 and 9 o'clock positions. Engine alignment is correct when no gap exists at any position. If a gap exists, proceed as follows (Figure 6):

GAP AT 12 O'CLOCK POSITION

Loosen locking nuts on front engine mounts. BOTH mounts MUST BE adjusted equally to keep engine level from side to side. Turn adjusting nut on both mounts equally counterclockwise to raise front of engine, until no gap exists. Tighten locking nuts securely (until lockwasher is compressed).

GAP AT 6 O'CLOCK POSITION

Loosen locking nuts on front engine mounts. BOTH mounts MUST BE adjusted equally to keep engine level from side to side. Turn adjusting nut on both mounts equally clockwise to lower front of engine, until no gap exists. Tighten locking nuts securely (until lockwasher is compressed).

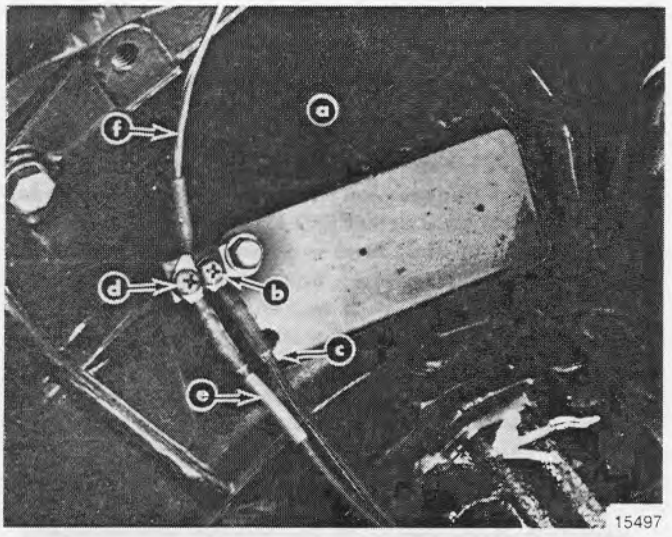
GAP AT 3 O'CLOCK POSITION

Loosen lag bolts which fasten front engine mounts to boat stringers and move engine to the right (starboard) until no gap exists. Retighten lag bolts securely.

GAP AT 9 O'CLOCK POSITION

Loosen lag bolts which fasten front engine mounts to boat stringers and move engine to the left (port) until no gap exists. Retighten lag bolts securely.

12. After correct alignment has been attained, re-check all mount fasteners to be sure that they are tight.
13. Remove alignment shaft and plate.
14. Retighten bellows clamps on exhaust manifold elbows (both sides).
15. Connect water inlet hose to seawater pump. Tighten clamp securely.
16. Connect instrument harness to engine harness. Secure with clamp and tighten securely.
17. Connect fuel line. Check for leaks.
18. Connect trim position sender wires as shown in Figure 7.



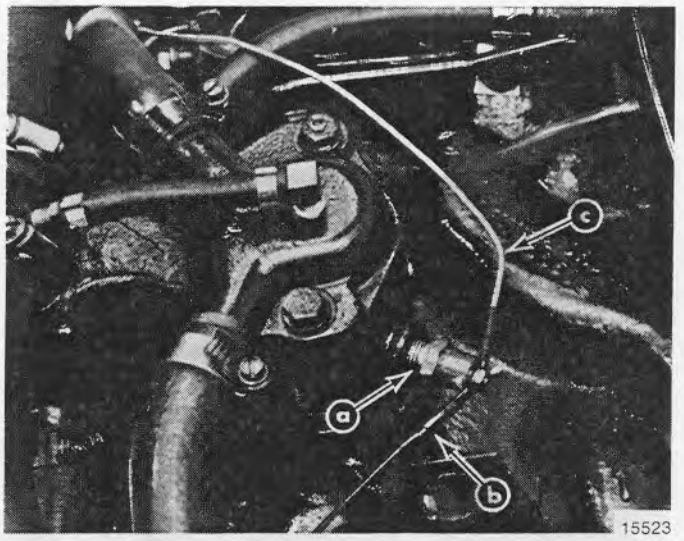
a - Flywheel Housing
b - Terminal Block Mounting Screw
c - Wire without Purple or Brown Sleeve
d - Insulated Terminal
e - Wire with Purple or Brown Sleeve
f - Brown/White Wire

Figure 7. Trim Position Sender Wires Connected to Terminal Block

a - Control Valve
b - Large Fitting
c - Small Fitting
— Torque to Specifications

Figure 9. Power Steering Connections

19. Connect tan/blue buzzer wire as shown in Figure 8.



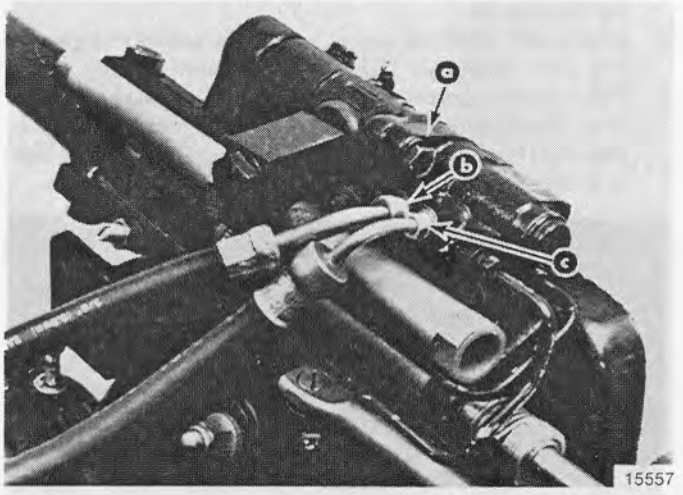
a - Cooling System Water Heat Switch
b - Tan/Blue Wire (From Oil Pressure Switch)
c - Tan/Blue Wire From Buzzer

Figure 8. Tan/Blue Buzzer Wire Connection

20. Connect any ground wires or accessories that may have been disconnected.
21. **Power Steering Models:** Reconnect fluid hoses as shown in Figure 9.

IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".

22. For shift and throttle connections, refer to the following:
    - "Attaching/Adjusting Shift Cable"
    - "Attaching/Adjusting Throttle Cable"
23. Connect battery cables to battery.



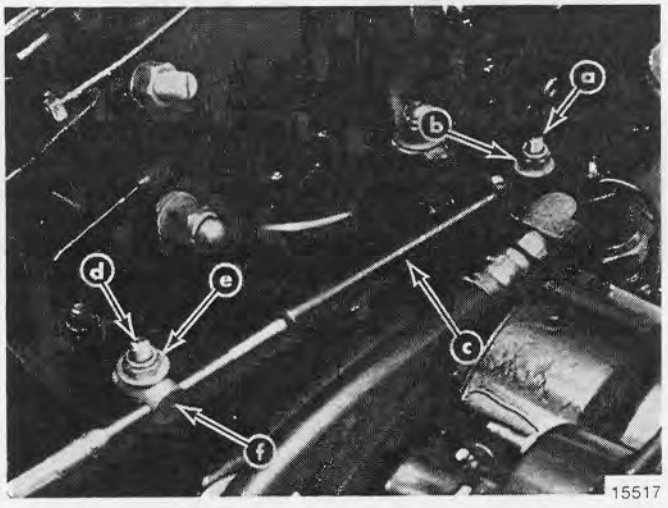
ATTACHING/ADJUSTING SHIFT CABLE

1. Place remote control shift lever in neutral position.
2. Place transmission shift lever in neutral position, indicated when poppet ball (located behind shift lever) is in center detent hole of shift lever. (Figure 1)

a - Shift Lever
b - Poppet Ball In Center Hole of Shift Lever

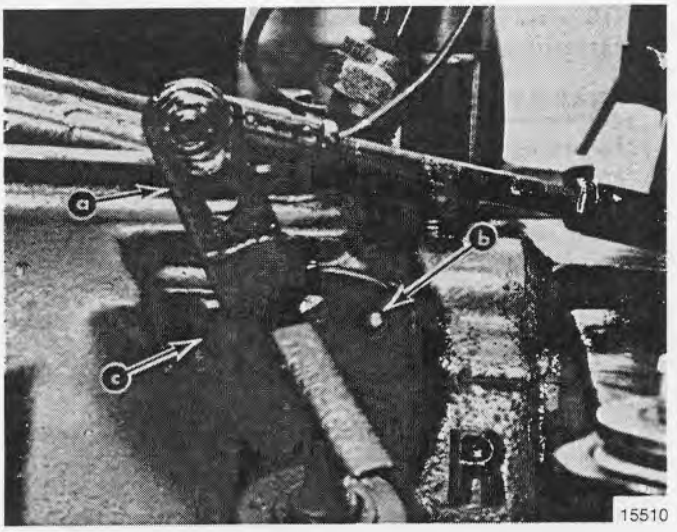
Figure 1. Neutral Position

3. Adjust brass barrel on shift cable, as required, to align shift cable attaching holes with shift cable lever and shift cable anchor studs. Center the cable end play travel when making adjustment.
4. Install shift cable and secure with flat washers and elastic stop nuts. (Figure 2) Tighten nuts to specifications.
5. Place remote control shift lever in full forward gear position. Check position of transmission shift lever. Transmission shift lever MUST BE positioned so that the poppet ball is in rear detent hole of shift lever. (Figure 3)



a - Lever Stud
b - Washer and Nut
c - Cable End Guide
d - Anchor Stud
e - Washer and Nut
f - Brass Barrel

Figure 2. Shift Cable Installed



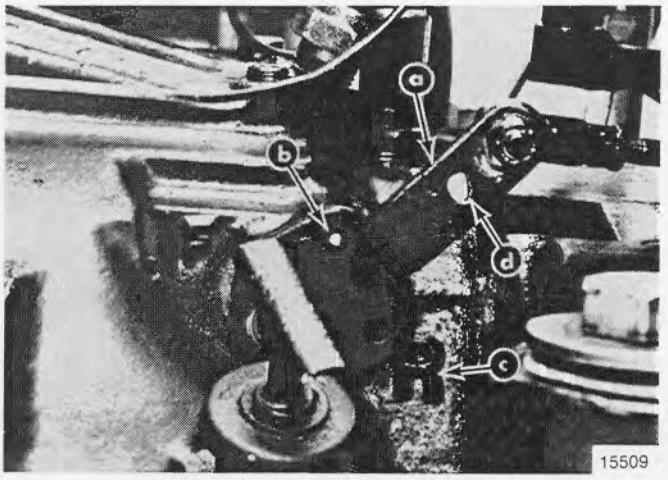
a - Shift Lever
b - Poppet Ball In Rear Detent Hole
c - "F" On Transmission Case

Figure 3. Forward Gear Position

6. Place remote control lever in full reverse gear position and, again, check transmission shift lever position. Poppet ball MUST BE in front detent hole of shift lever. (Figure 4)
7. If transmission shift lever is positioned correctly in one gear (forward or reverse), but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move shift rod stud from top hole in transmission shift lever to bottom hole (Figure 4) and recheck for proper positioning of shift lever. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and MUST BE replaced.

⚠CAUTION

Remote control and shift cable MUST position transmission shift lever so that it is fully in the forward and reverse gear detent position and over the letter "F" on transmission case when propelling boat forward. TRANSMISSION SHIFT LEVER MUST BE POSITIONED PROPERLY (WITHOUT ANY MODIFICATION TO TRANSMISSION) OR TRANSMISSION FAILURE MAY OCCUR. Warner Gear Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed; if the shift lever is repositioned or changed in any manner; or remote control and cable do not position shift lever correctly.

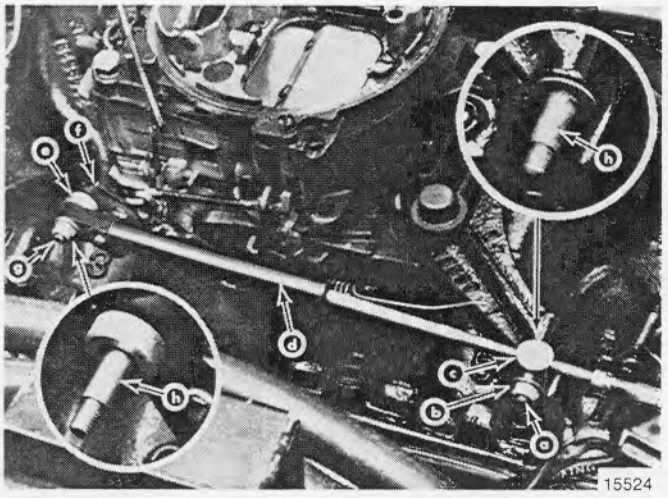


a - Shift Lever
b - Poppet Ball In Front Detent Hole
c - "R" On Transmission Case
d - Install Shift Rod Stud in This Hole, If Necessary, To Properly Position Shift Lever With Poppet Ball

Figure 4. Reverse Gear Position

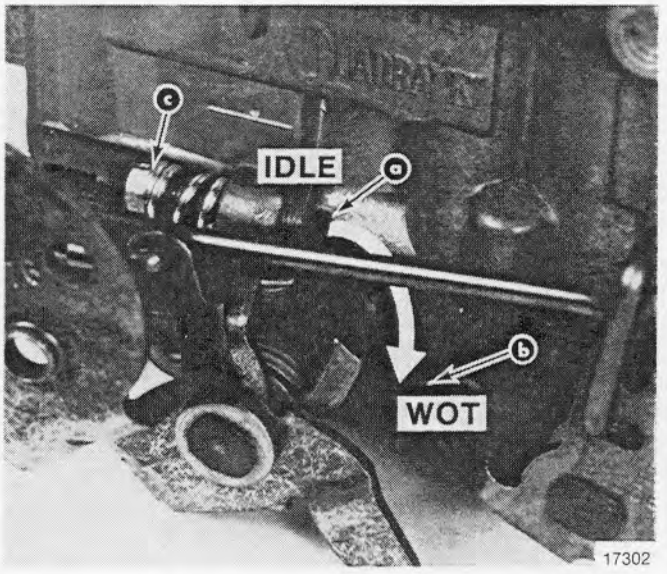
ATTACHING/ADJUSTING THROTTLE CABLE

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown in Figure 1.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown in Figure 1.



a - Anchor Stud
b - Washer and Nut (DO NOT Over-Tighten)
c - Brass Barrel
d - Cable End Guide
e - Spacer
f - Screw
g - Washer and Nut (DO NOT Over-Tighten)
h - Bushing

Figure 1. Throttle Cable Installed



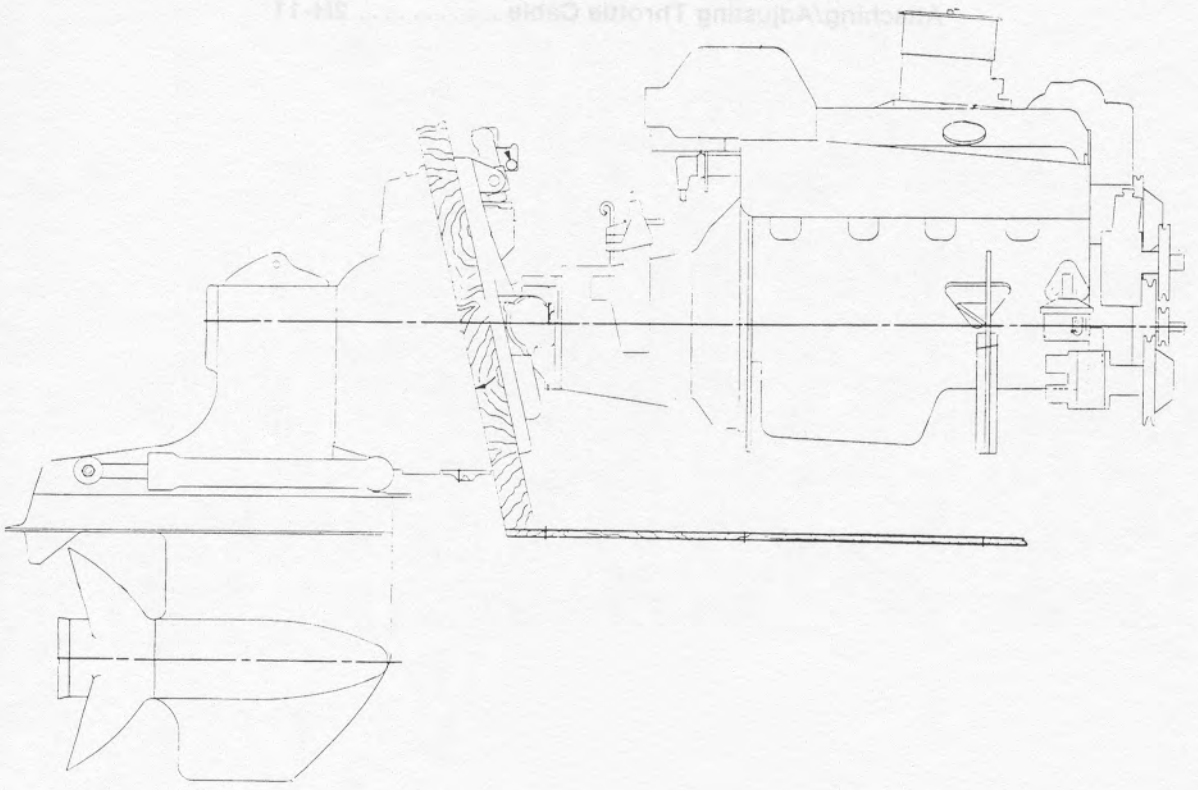
a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

Figure 2. Idle/Full Throttle Check

4. Check that throttle valves are fully open when remote control is in full throttle position. (Figure 2)
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop. (Figure 2)

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART H - MCM 370/400 TRS and HI-PERFORMANCE ENGINES



MERCURY MARINE
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STERN DRIVES & INBOARDS

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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Driveshaft to Tailstock Flange	50 (68) (Note 2)	
Driveshaft to Transmission Output Flange	35 (48)	
Front Engine Plate Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings Large	20-25 (27-34)	
Small		96-108 (11-12)
Rear Engine Mounts (Transom Mounted Engine)	100 (136)	
Rear Engine Plate Mount	Securely	
Remote Control Shift Cable Brass Barrel	(Note 1)	
Cable End Guide	(Note 1)	
Remote Control Throttle Cable Brass Barrel	(Note 1)	
Cable End Guide	(Note 1)	
Tailstock Housing Compression Nuts		70 (8)
Tailstock Mounts	100 (136)	

NOTES: 1. Tight, then back nut off 1/2 turn.
2. Secure with safety wire.

TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Multi-Lube

NOTICE

This section contains repair procedures primarily for MCM 370/400 TRS models. It can be used as a guide for the Hi-Performance models listed, however, Mercury Marine can not possibly list the differences between each model.

MCM 400 Cyclone TRS **MCM 460 Cyclone TRS**
MCM 440 Cyclone TRS **MCM 475 Turbo TRS**

II SSM and III SSM Models: Engine removal and installation is basically the same as TRS models.

REMOVAL

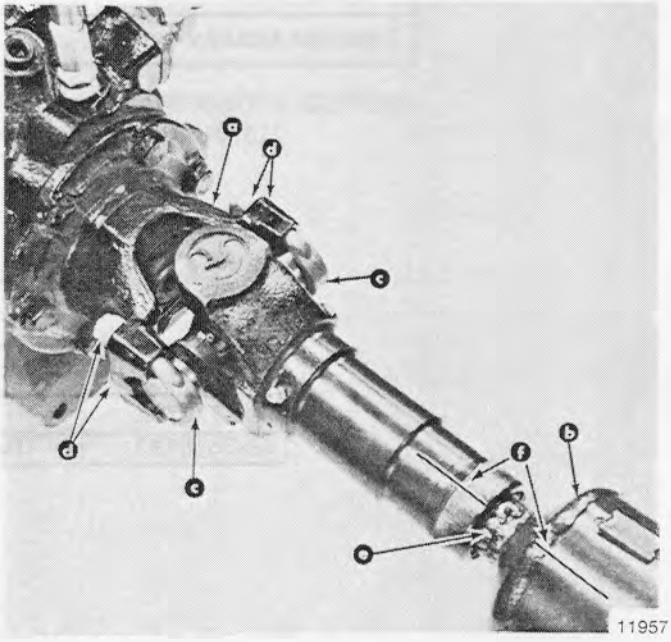
NOTICE
Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual."

1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Disconnect trim position sender wire (some models).
4. Remove red and black Power Trim pump motor wires from engine (some models).
5. Disconnect water inlet hose and exhaust system.
6. Remove shift cable.
7. Disconnect any grounding wire or accessories that are connected to the engine.
8. **Power Steering Models:**
   a. Fluid Cooler Mounted on Engine: Disconnect fluid hoses from power steering control valve.
   b. Fluid Cooler Mounted on Stringer: Disconnect fluid hoses from cooler.
9. **Models with Transmission Oil Cooler Mounted on Stringer:** Disconnect oil hoses from cooler. Mark location each hose was removed from.
10. **Models with Engine Oil Cooler Mounted on Stringer:** Disconnect oil hoses from cooler. Mark location each hose was removed from.
11. Disconnect hydraulic hoses from reverse lock valve located on transmission (some models).
12. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
13. **Transom Mounted Engine:** Pull engine forward to disengage transmission output housing from gimbal housing and carefully remove engine.

⚠CAUTION

Driveshaft has been assembled and balanced at the factory with the universal joint yoke on both ends of shaft running in the same plane. If it is necessary to remove splined end of shaft, end MUST BE reinstalled in splines in exactly the same position as factory assembled, or damage to universal joints and driveshaft may result.

14. **Engine with Driveshaft:**
Method A: Mark driveshaft in two locations as shown in Figure 1. Pull engine forward to disengage driveshaft splines and carefully remove engine.
Method B: Disconnect driveshaft from transmission output shaft as shown in Figure 1. Carefully remove engine.



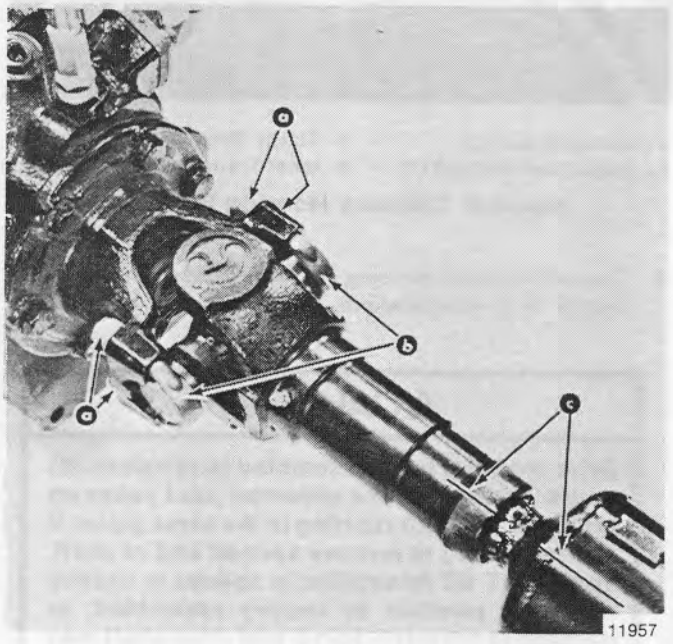
a - Transmission Output Shaft
b - Driveshaft
c - U-Bolts (2)
d - Elastic Stop Nuts (4)
e - Splines
f - Make Alignment Marks With Paint

Figure 1. Driveshaft Models

REMOVAL/INSTALLATION OF DRIVESHAFT and TAILSTOCK HOUSING (ENGINES WITH DRIVESHAFT)

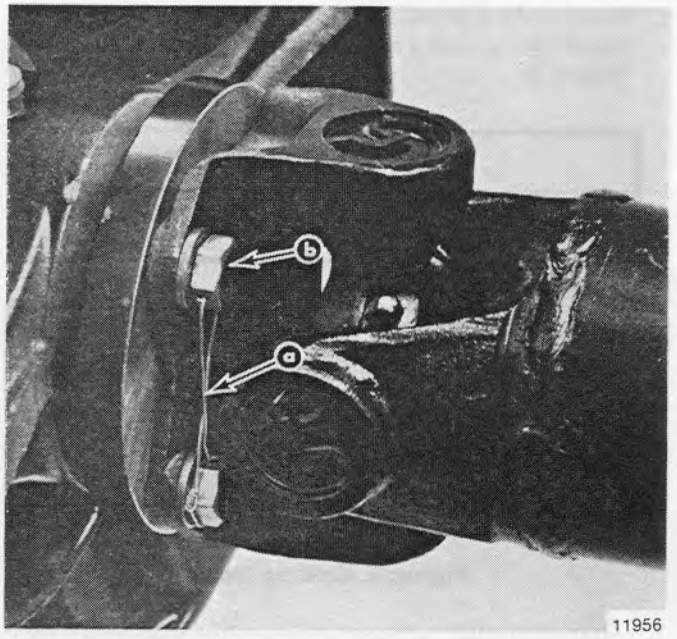
REMOVAL

1. Disconnect both ends of driveshaft as shown in Figures 1 and 2.



a - Remove 4 Nuts
b - Remove 2 U-Bolts
c - Make Alignment Marks With Paint

Figure 1. Engine End



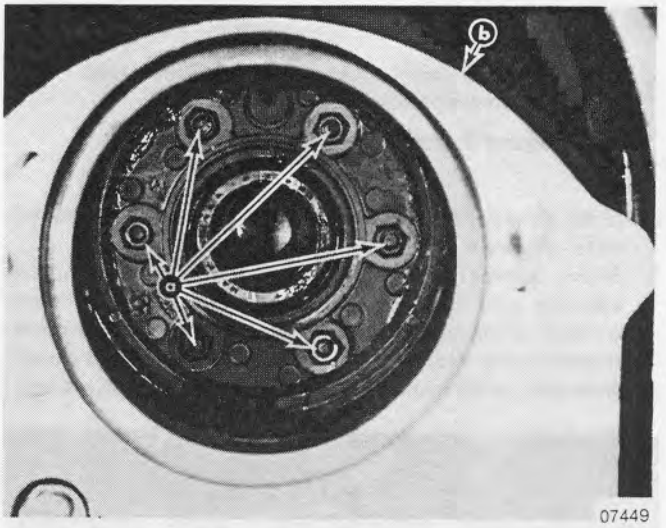
a - Cut Safety Wire
b - Remove 4 Bolts and Washers

Figure 2. Tailstock End

⚠CAUTION

Driveshaft has been assembled and balanced at the factory with the universal joint yokes on both end of shaft running in the same plane. If it is necessary to remove splined end of shaft, mark driveshaft in two locations as shown in Figure 1. Driveshaft splines must be aligned in exactly the same position as factory assembled, or damage to universal joints and driveshaft may occur.

2. Remove driveshaft.
3. Loosen tailstock compression nuts. (Figure 3)



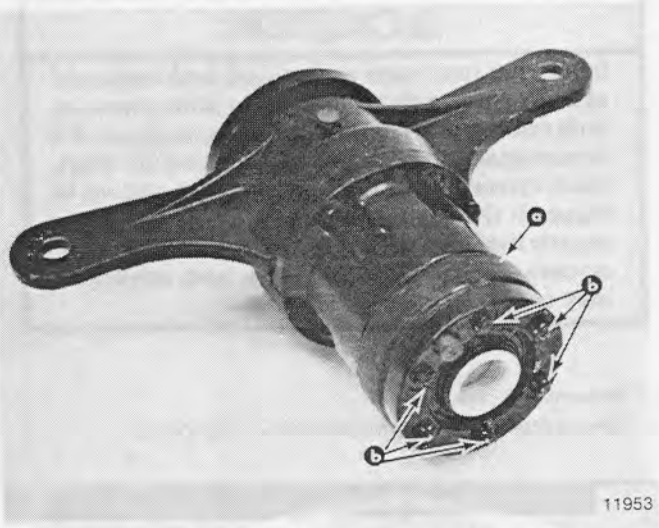
a - Compression Nuts
b - Bell Housing

Figure 3. Loosen Compression Nuts

4. Remove tailstock housing to inner transom plate support fasteners.
5. Remove tailstock housing from opening in gimbal housing.

INSTALLATION

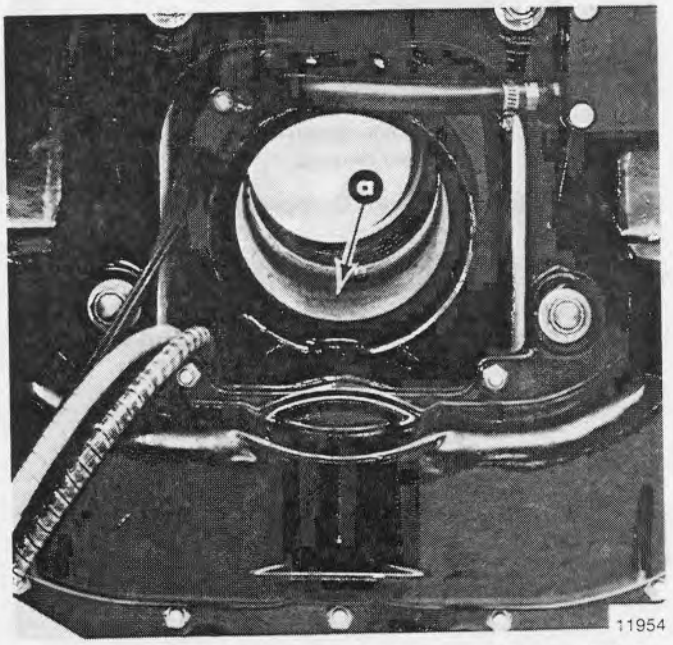
1. Lubricate rubber "O" ring seal on tailstock housing assembly (Figure 4) and opening in gimbal housing (Figure 5) with 2-4-C Multi-Lube.



a - "O" Ring Seal (Lubricate with 2-4-C Multi-Lube)
b - Compression Nuts (6)

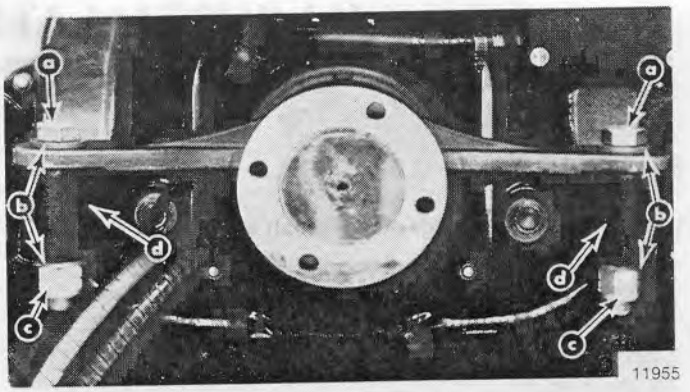
Figure 4. Tailstock Housing Assembly

2. If not already done, loosen tailstock housing compression nuts. (Figure 4)
3. Insert tailstock housing assembly into gimbal housing opening until holes in housing align with holes in inner transom plate supports. Secure tailstock housing to inner transom plate supports with bolts, flat washers and elastic stop nuts, as shown in Figure 6. Torque to specifications.



a - Gimbal Housing Opening (Lubricate with 2-4-C Multi-Lube)

Figure 5. Gimbal Housing Opening



a - Mounting Bolt (2)
b - Large Steel Washers (4)
c - Elastic Stop Nut (2)
d - Inner Transom Plate Support (2)

Figure 6. Tailstock Housing Installed

4. Torque 6 tailstock housing "O" ring seal compression nuts (Figure 3) to specifications.

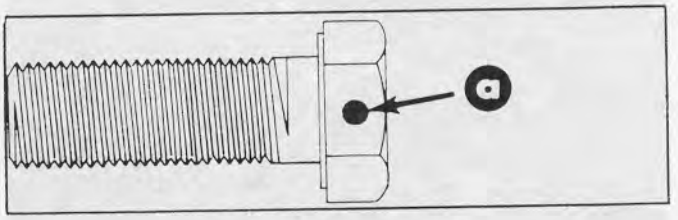
⚠CAUTION

Drive shaft has been assembled (and balanced) at the factory with the universal joint yokes on both ends of shaft running in the same plane. If it is necessary to remove splined end of shaft, end MUST BE reinstalled in splines in exactly the same position as factory assembled, or damage to universal joints and drive shaft may result.

5. Attach driveshaft to tailstock housing flange with bolts and washers. Torque to specifications.
6. Secure bolts with stainless steel safety wire, being sure to install wire in such a manner that it does not loosen bolts. (Figure 2)

⚠CAUTION

If bolts do not have hole in head for safety wire, drill as shown in Figure 7.



a - 1/16" (2mm) Dia. Hole

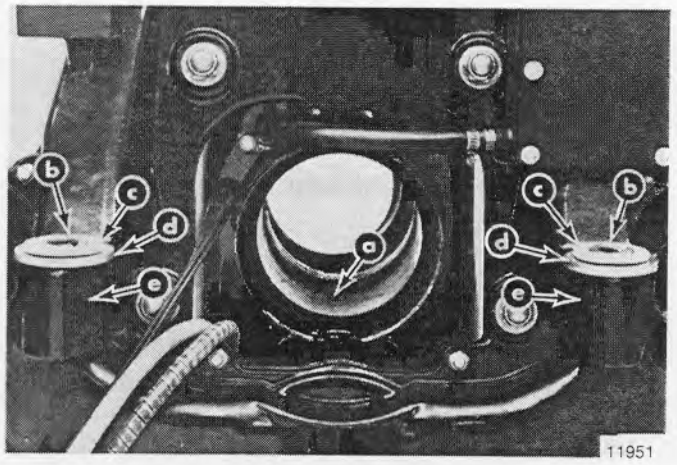
Figure 7. Drilling Bolts

7. Attach driveshaft to transmission output shaft with U-bolts and elastic stop nuts. Torque to specifications.
8. Install engine as outlined under "Installation/Alignment".

INSTALLATION/ALIGNMENT

TRANSOM MOUNTED ENGINE

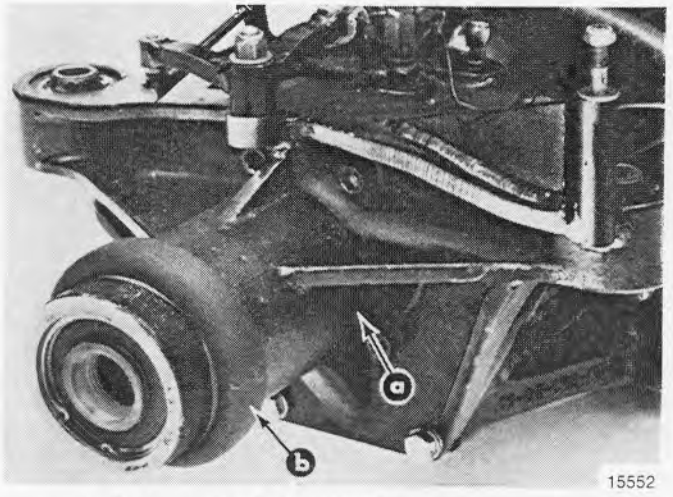
1. Prepare transom assembly as shown in Figure 1.



a - Gimbal Housing Opening
(Lubricate with 2-4-C Multi-Lube)
b - Double-Wound Lockwasher (2)
c - Fiber Washer (2)
d - Large Steel Washer (2)
e - Engine Supports

Figure 1. Preparing Transom Assembly

2. Prepare transmission output housing as shown in Figure 2.



a - Transmission Output Housing
b - "O" Ring Seal (Lubricate with 2-4-C Multi-Lube)

Figure 2. Transmission Output Housing

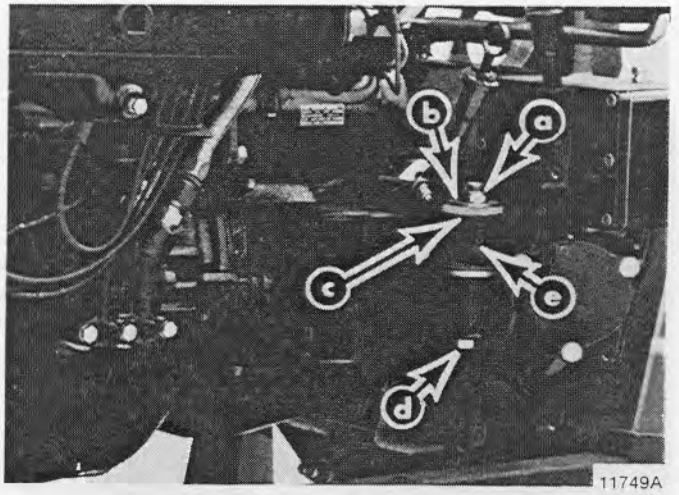
3. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine.
4. Position engine ahead of inner transom plate so that transmission output housing (Figure 2) is in line with large opening in inner transom plate. (Figure 1)

IMPORTANT: Take care when installing engine in next step to prevent damage to "O" ring seal on transmission output housing.

5. Carefully guide transmission output housing into transom gimbal housing assembly until holes in rear engine mounts align with holes in inner transom plate engine supports.

IMPORTANT: DO NOT relieve hoist tension entirely, as inner transom plate engine supports and/or transmission output housing may be damaged.

6. Relieve hoist tension, as required, to allow rear engine mounts to rest on inner transom plate engine supports and washers.
7. Insert mounting bolts up thru inner and rear mounts as shown in Figure 3. Torque to specifications.



a - Elastic Stop Nut
b - Steel Washer
c - Fiber Washer
d - Bolt
e - Rear Engine Mount

Figure 3. Securing Rear Engine Mounts

8. Insert solid end of Alignment Tool thru bell housing bore and into transmission output housing until it bottoms. (Figure 4) Slide plate toward bell housing and position bell housing, as required, to allow shoulder on plate to enter bell housing bore. (Figure 5)

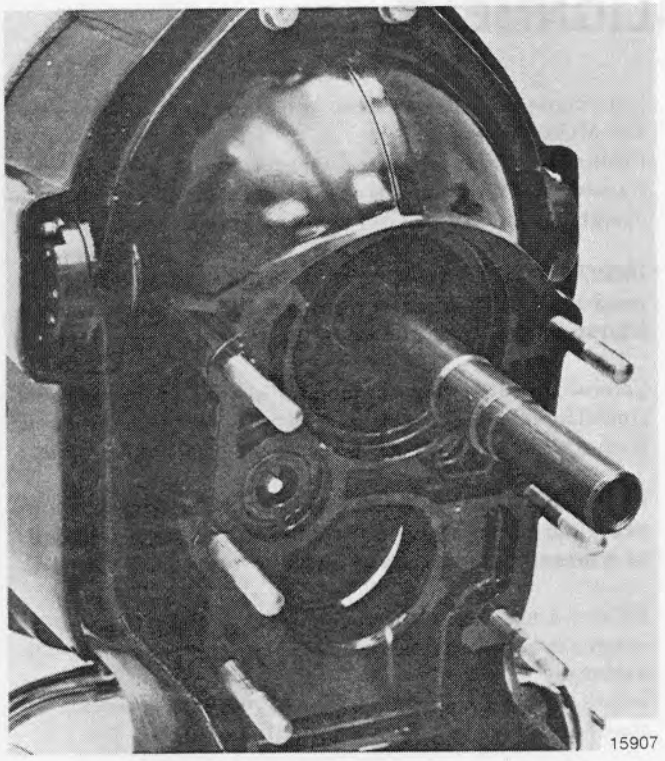


Figure 4. Engine Alignment Tool Installed

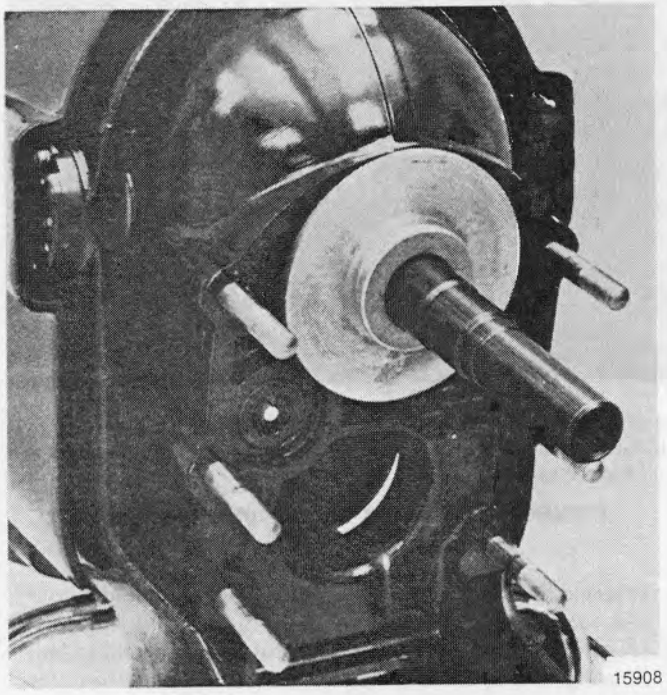


Figure 5. Engine Alignment Tool Plate in Position

9. While pushing in on alignment shaft and plate, check for gap between plate and bell housing rear surface at 12, 3, 6 and 9 o'clock positions. Engine alignment is correct when no gap exists at any position. If a gap exists, proceed as follows:

Gap at 12 o'clock Position

Raise front of engine with hoist, as required, until gap no longer exists.

Gap at 6 o'clock Position

Lower front of engine with hoist, as required, until gap no longer exists.

Gap at 3 o'clock Position

Move engine to the right (starboard) until gap no longer exists.

Gap at 9 o'clock Position

Move engine to the left (port) until gap no longer exists.

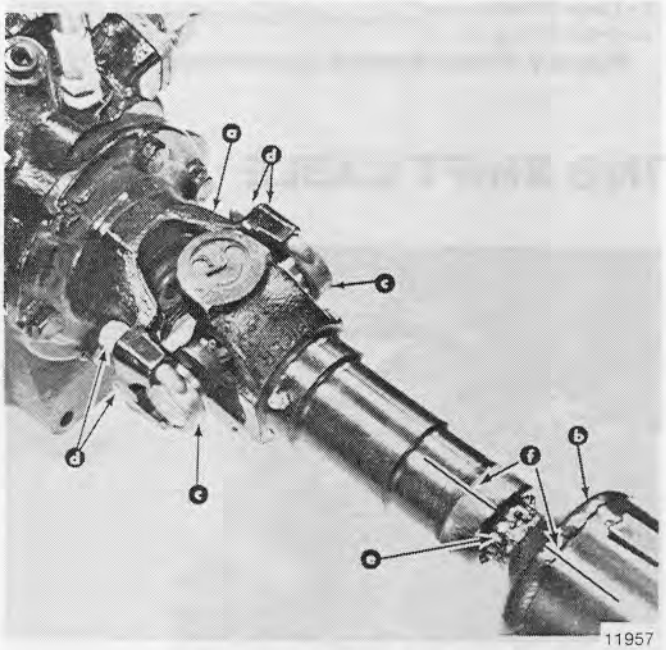
10. After correct alignment has been attained, fasten front plate mount to angle irons. Tighten fasteners securely.
Engine with rear plate mount: Fasten rear plate mount to angle irons. Tighten fasteners securely.
11. After engine has been fastened securely to boat, recheck engine alignment to ensure that engine has not moved; then remove alignment tool.
12. Refer to "Completing Installation".

ENGINES WITH DRIVESHAFT

1. If removed, install tailstock housing to inner transom plate as outlined.
2. If removed, install driveshaft to flange on tailstock housing as outlined.
3. Attach a suitable sling to lifting eyes on engine and lift engine into boat. Position engine in its approximate mounting location.
4. Method A: Attach drive shaft to transmission output shaft with U-bolts and elastic stop nuts. (Figure 6) Torque nuts to specifications.
   Method B: Align painted alignment marks on each half of driveshaft and slide splined shafts together. (Figure 6)

⚠CAUTION

Driveshaft has been assembled (and balanced) at the factory with the universal joint yoke on both ends of shaft running in the same plane. If it is necessary to remove splined end of shaft, end MUST BE reinstalled in splines in exactly the same position as factory assembled, or damage to universal joints and driveshaft may result.



a - Transmission Output Shaft
b - Driveshaft
c - U-Bolts (2)
d - Elastic Stop Nuts (4)
e - Splines
f - Painted Alignment Marks

Figure 6. Driveshaft Attached to Transmission Output Shaft

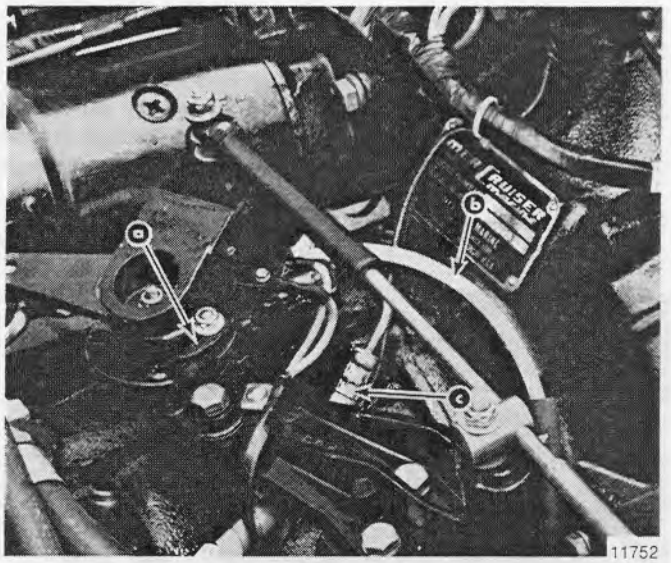
⚠CAUTION

Engine MUST BE positioned correctly (as described in next step) to achieve proper engine operation and to prevent damage to drive shaft. If drive shaft is run at incorrect angle damage to universal joint bearings may result.

5. Position engine so that it is 1″ to 1-5/16″ (25 to 33mm) above or below starboard engine and parallel to crankshaft centerline of starboard engine (both vertically and horizontally). Also, make sure that engine is directly in line with tailstock housing. Move engine back-or-forward, as required, so that driveshaft splines (Figure 6) are positioned at approximately mid travel. This position will place driveshaft at a 1°-3° angle to crankshaft centerline which is necessary for proper drive shaft operation.
6. After engine has been positioned correctly, fasten front and rear plate mounts to angle irons using fasteners that had been removed. Tighten bolts and nuts securely.
7. Refer to "Completing Installation".

COMPLETING INSTALLATION

1. Connect hydraulic hoses to reverse lock valve as shown in Figure 7 (some models).
2. **Models with Engine Oil Cooler Mounted on Stringer:** Connect oil hoses to the same fittings that they were removed from.
3. **Models with Transmission Oil Cooler Mounted on Stringer:** Connect oil hoses to the same fittings that they were removed from.



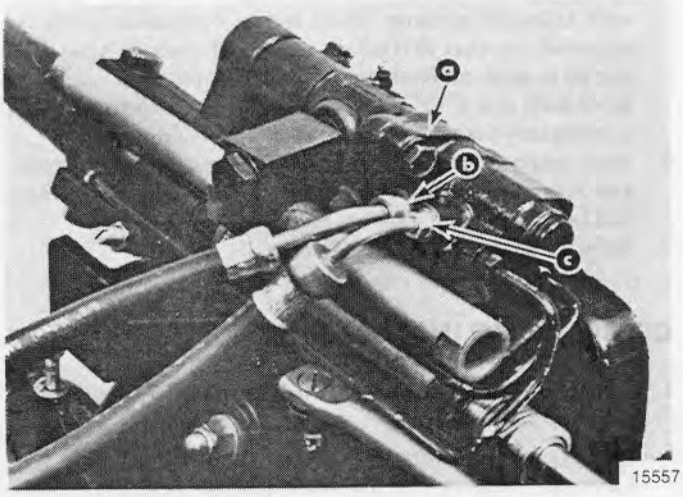
a - Reverse Lock Valve
b - Plastic Hose (From Power Trim Pump)
c - Gray Hose (From Transom Assembly)

Figure 7. Reverse Lock Valve (Some Models)

IMPORTANT: Check all oil levels before and after first 5 minutes of running time.

4. Power Steering Models:
   a. Fluid Cooler Mounted on Engine: Reconnect fluid hoses to power steering control valve as shown in Figure 8.
   b. Fluid Cooler Mounted on Stringer: Reconnect fluid hoses to cooler.

IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".



a - Control Valve
b - Large Fitting — Torque to Specifications
c - Small Fitting — Torque to Specifications

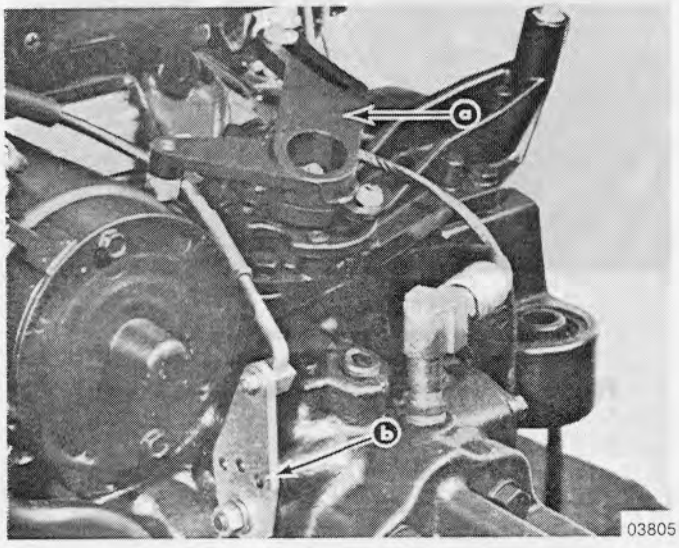
Figure 9. Power Steering Connections

5. Reconnect any grounding wire or accessories that were removed.
6. Connect shift cable. Refer to "Attaching/Adjusting Shift Cable".
7. Reconnect trim position sender wire (some models).
8. Reconnect seawater inlet hose and exhaust system. Tighten clamps securely.
9. Reconnect red and black Power Trim pump motor wires to engine (some models).
10. Reconnect fuel line. Check for fuel leaks.
11. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
12. Connect instrument harness to engine harness. Secure with clamp and tighten securely.
13. Connect battery cables to battery.

ATTACHING/ADJUSTING SHIFT CABLE

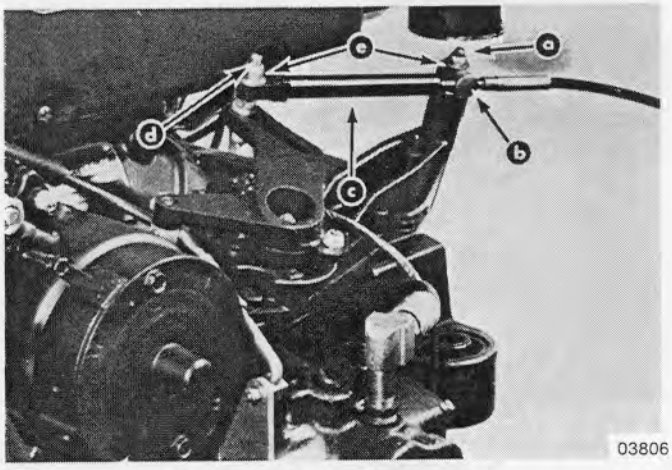
MODELS WITH REVERSE LOCK VALVE

1. Place remote control handle in full forward position.
2. Place transmission in forward gear by moving shift cable lever to the right until detent ball, which is located behind transmission shift lever, is centered in rear hole in transmission shift lever. (Figure 1)
3. Place cable end guide on stud which is located in shift cable lever. (Figure 2)



a - Shift Lever
b - Rear Hole and Detent Ball

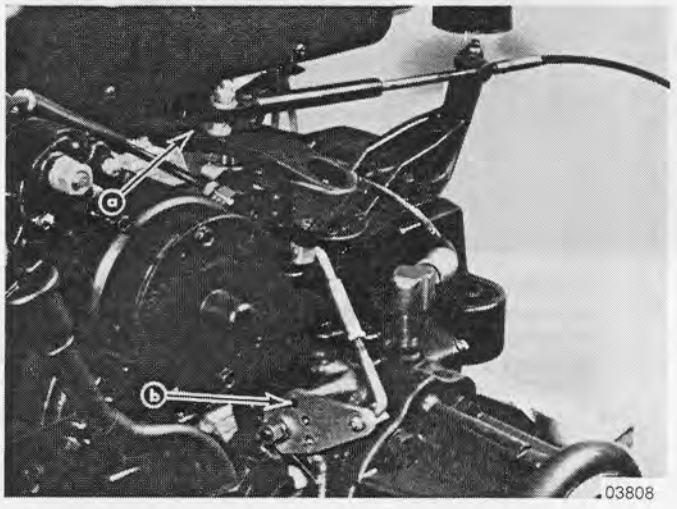
Figure 1. Forward Gear



a - Anchor Stud
b - Brass Barrel
c - Cable End Guide
d - Stud
e - Washer and Nut

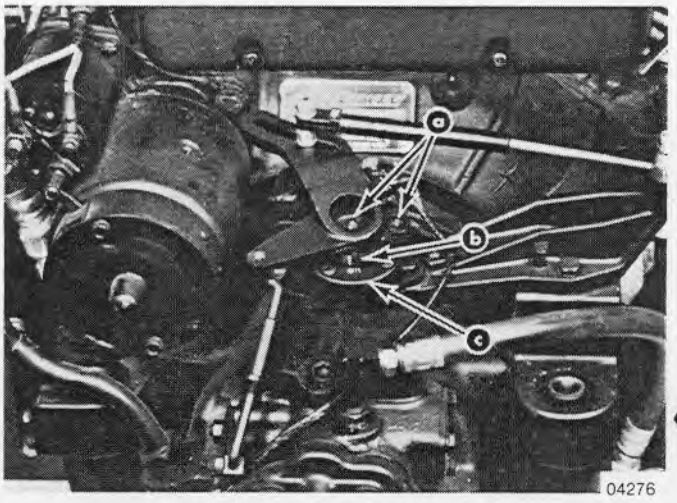
Figure 2. Shift Cable Installed

4. Adjust brass barrel on shift cable so that barrel can be placed on anchor stud without disturbing shift cable lever position. (Figure 2)
5. Fasten end guide to shift cable lever stud with flat washer and nut. Tighten nut and then back nut off slightly to allow end guide to pivot freely. (Figure 2)
6. Fasten brass barrel to anchor stud with flat washer and nut. Tighten nut securely. (Figure 2)
7. Place remote control handle in full reverse position.
8. Loosen nut which fastens stud to shift cable lever. Move shift cable lever to the left, while sliding stud down slot in lever, until detent ball is centered in front hole in transmission shift lever. Tighten nut securely. (Figure 3)
9. Check adjustment by moving remote control handle to full forward. Detent ball must be centered in rear hole in transmission shift lever. (Figure 1) Move control handle to full reverse position. Detent ball must be centered in front hole in transmission shift lever. (Figure 3) If transmission shift lever is not positioned correctly and does not permit detent ball to be centered in holes, as described previously, readjust cable.
10. Move remote control handle to full reverse position.
11. Mark, which is located on valve cam lever, and large mark, located on valve cover, must line up as shown in Figure 4. If marks do not line up as shown, loosen nuts "A" and reposition cam lever. Tighten nuts securely after adjustment.



a - Slot
b - Front Hole and Detent Ball

Figure 3. Reverse Gear



a - Adjustment Nuts b - Cam Lever c - Valve Cover

Figure 4. Reverse Lock Valve Adjustment

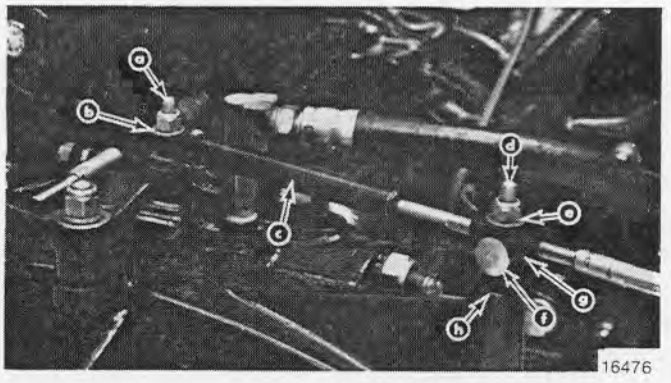
MODELS WITHOUT REVERSE LOCK VALVE

1. Place remote control shift lever in neutral position.
2. Place transmission shift lever in neutral position, indicated when poppet ball (located behind shift lever) is in center detent hole of shift lever. (Figure 5)

a - Shift Lever
b - Poppet Ball In Center Hole of Shift Lever

Figure 5. Neutral Position

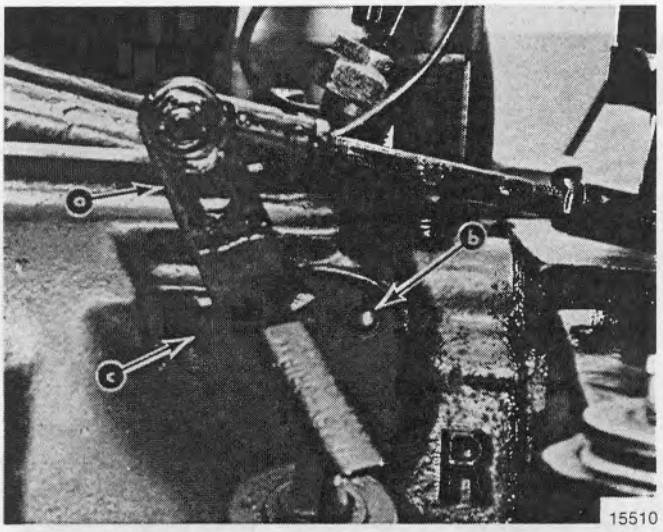
3. Adjust brass barrel on shift cable, as required, to align shift cable attaching holes with shift cable lever and shift cable anchor studs. Center the cable end play travel when making adjustment.
4. Install shift cable and secure with flat washers and elastic stop nuts. (Figure 6) Tighten nuts to specifications.



a - Lever Stud
b - Washer and Nut
c - Cable End Guide
d - Anchor Stud
e - Washer and Nut
f - Brass Barrel
g - Shift Cable Barrel Clamp Block
h - Washer

Figure 6. Models Without Reverse Lock Valve

5. Place remote control shift lever in full forward gear position. Check position of transmission shift lever. Transmission shift lever MUST BE positioned so that the poppet ball is in rear detent hole of shift lever. (Figure 7)



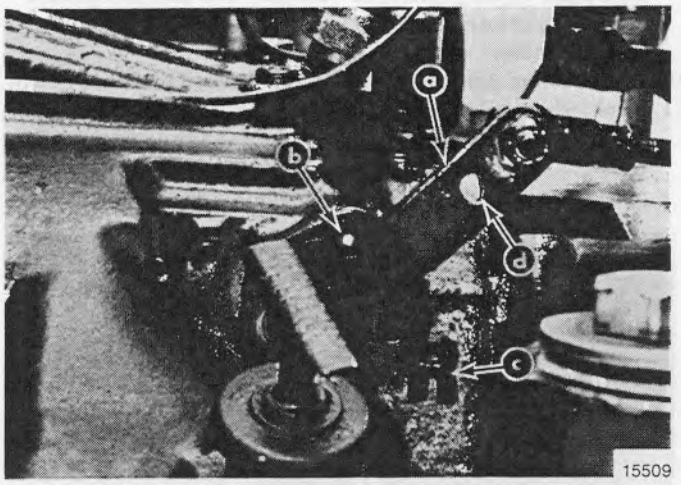
a - Shift Lever
b - Poppet Ball In Rear Detent Hole
c - "F" On Transmission Case

Figure 7. Forward Gear Position

6. Place remote control lever in full reverse gear position and, again, check transmission shift lever position. Poppet ball MUST BE in front detent hole of shift lever. (Figure 8)
7. If transmission shift lever is positioned correctly in one gear (forward or reverse), but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move shift rod stud from top hole in transmission shift lever to bottom hole (Figure 8) and recheck for proper positioning of shift lever. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and MUST BE replaced.

⚠CAUTION

Remote control and shift cable MUST position transmission shift lever so that it is fully in the forward and reverse gear detent position and over the letter "F" on transmission case when propelling boat forward. TRANSMISSION SHIFT LEVER MUST BE POSITIONED PROPERLY (WITHOUT ANY MODIFICATION TO TRANSMISSION) OR TRANSMISSION FAILURE MAY OCCUR. Warner Gear Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed; if the shift lever is repositioned or changed in any manner; or remote control and cable do not position shift lever correctly.

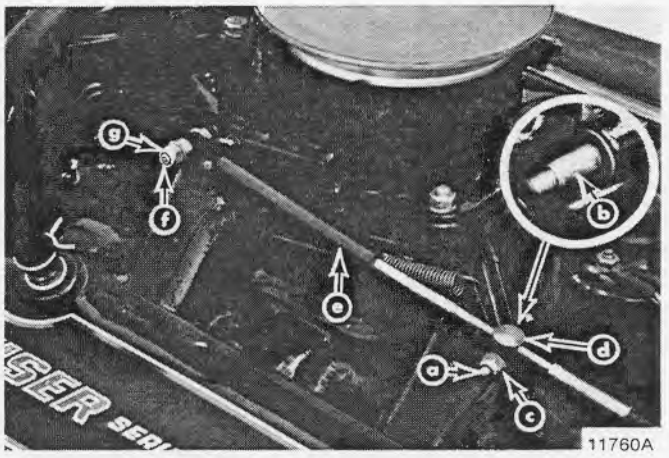


a - Shift Lever
b - Poppet Ball In Front Detent Hole
c - "R" On Transmission Case
d - Install Shift Rod Stud in This Hole, If Necessary, To Properly Position Shift Lever With Poppet Ball

Figure 8. Reverse Gear Position

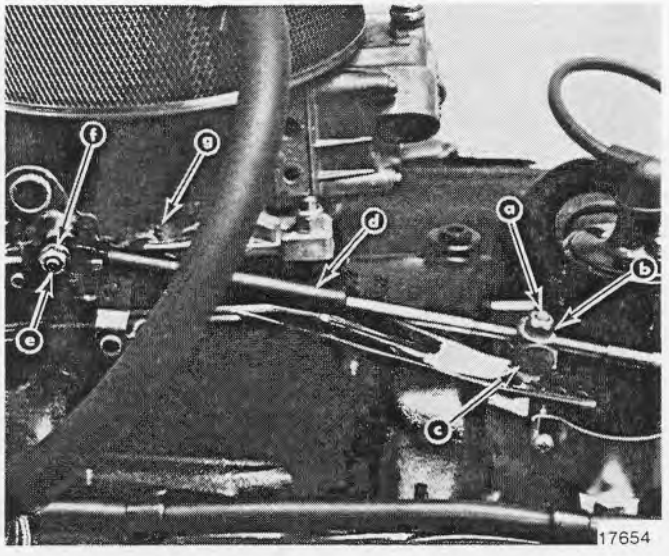
ATTACHING/ADJUSTING THROTTLE CABLE

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown in Figure 1, 2, or 3.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown in Figure 1, 2, or 3.



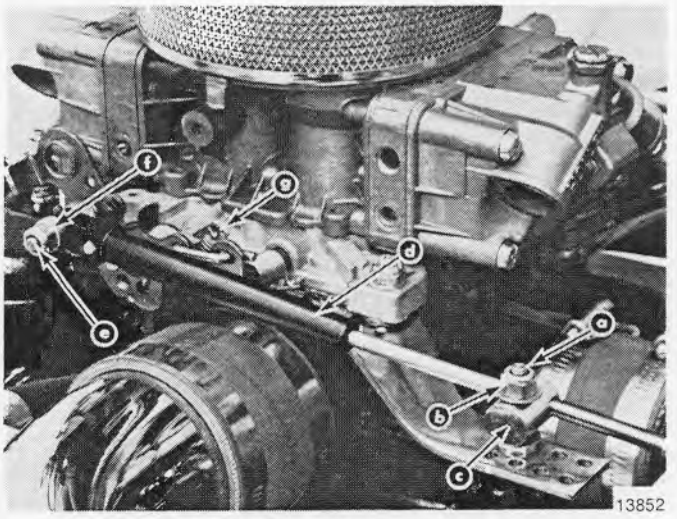
a - Anchor Stud
b - Bushing
c - Washer and Nut (DO NOT Over-Tighten)
d - Brass Barrel
e - Cable End Guide
f - Lever Stud
g - Washer and Nut (DO NOT Over-Tighten)

Figure 1. MCM 370/400/400 Cyclone



a - Anchor Stud
b - Washer and Nut (DO NOT Over-Tighten)
c - Brass Barrel
d - Cable End Guide
e - Lever Stud
f - Washer and Nut (DO NOT Over-Tighten)
g - Idle RPM Adjustment Screw

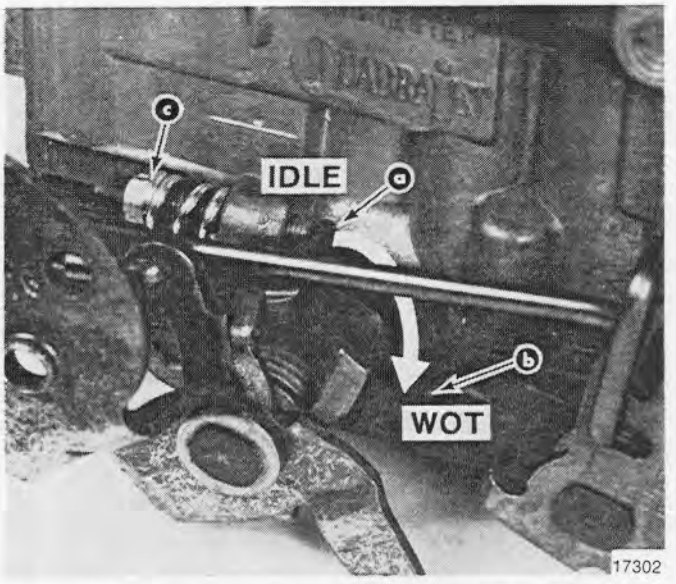
Figure 2. MCM 440/460 Cyclone



a - Anchor Stud
b - Washer and Nut (DO NOT Over-Tighten)
c - Brass Barrel
d - Cable End Guide
e - Lever Stud
f - Washer and Nut (DO NOT Over-Tighten)
g - Idle RPM Adjustment Screw

Figure 3. MCM 475 Turbo

4. Check that throttle valves are fully open when remote control is in full throttle position. (Figure 4)
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop. (Figure 2, 3 or 4)

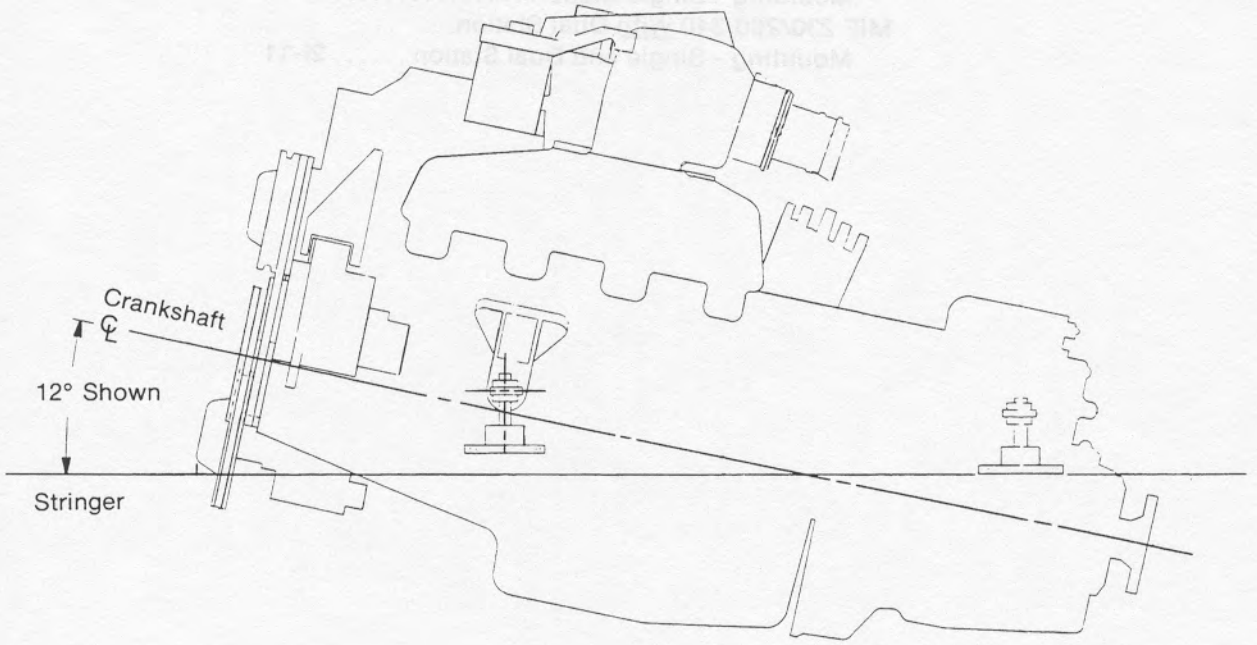


a - Tang b - Carburetor Body c - Idle RPM Adjustment Screw

Figure 4. Idle/Full Throttle Check (Rochester Carburetors Only)

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

PART I - MIE 470-228-230-255-260-330-340



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Battery Cables	Securely
Engine Mount Pads	Securely
Hose Clamps	Securely
Mount Locking Nut	Securely (Note 2)
Propeller Shaft Coupling	50 (68)
Remote Control Shift Cable Brass Barrel Cable End Guide	 Securely (Note 1)
Remote Control Throttle Cable Brass Barrel Cable End Guide	 Securely (Note 1)
Trunnion Clamping Screw/Nut	50 (68)

NOTES:

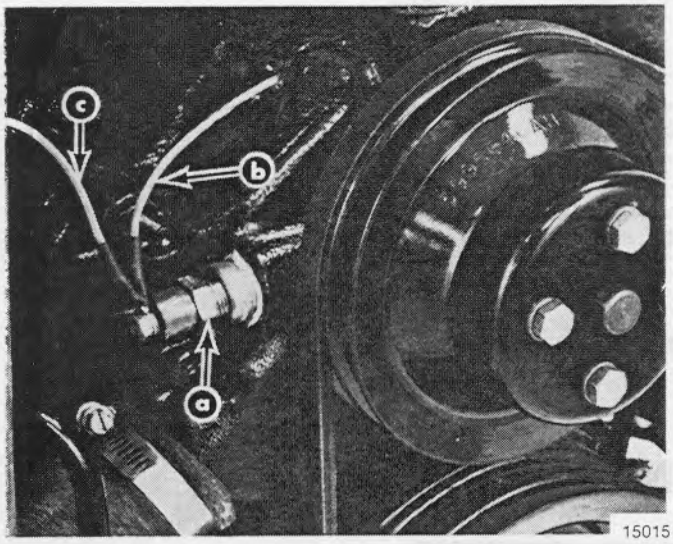
1. *Tighten, then back nut off 1/2 turn.*
2. *Bend tab against adjusting nut.*

LUBRICANTS

LUBRICANTS	
92-86154A1	Quicksilver 2-4-C Multi-Lube

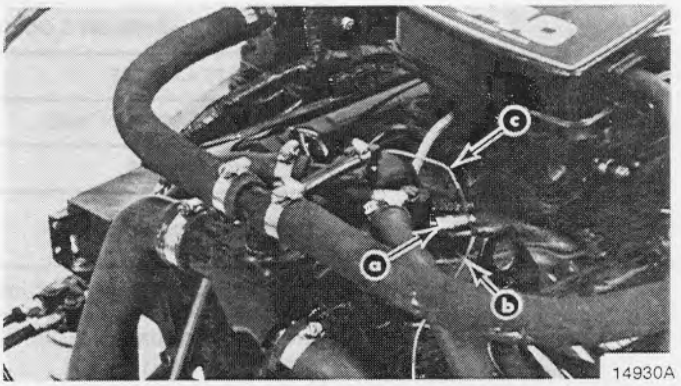
REMOVAL

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Disconnect shift cable.
4. Disconnect water inlet hose and exhaust system.
5. Disconnect any ground wires or accessories that are connected to engine.
   MIE 230/260/340: Disconnect audio warning system tan/blue wire as shown in Figure 1 or 2.



a - Water Heat Switch
b - Tan/Blue Wire (Jumper Wire to Engine Oil Pressure Switch)
c - Disconnect Tan/Blue Wire (From Buzzer)

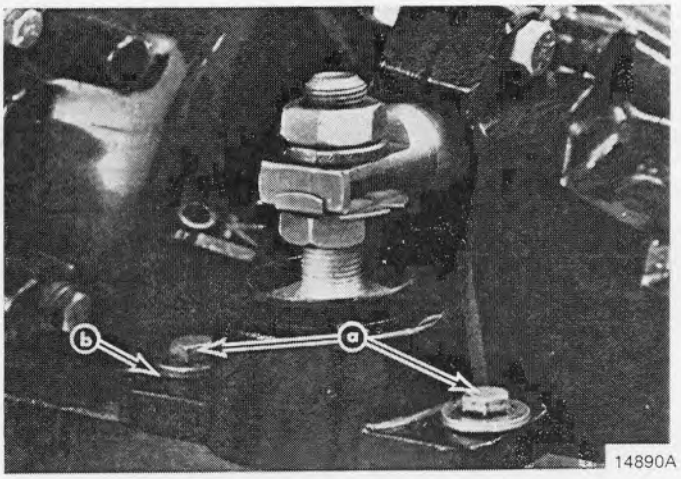
Figure 1. MIE 230/260



a - Water Heat Switch
b - Tan/Blue Wire (Jumper Wire to Engine Oil Pressure Switch)
c - Disconnect Tan/Blue Wire (From Buzzer)

Figure 2. MIE 340

5. Disconnect propeller shaft coupling from transmission coupling.
6. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts. (Figure 3)
7. Carefully remove engine.

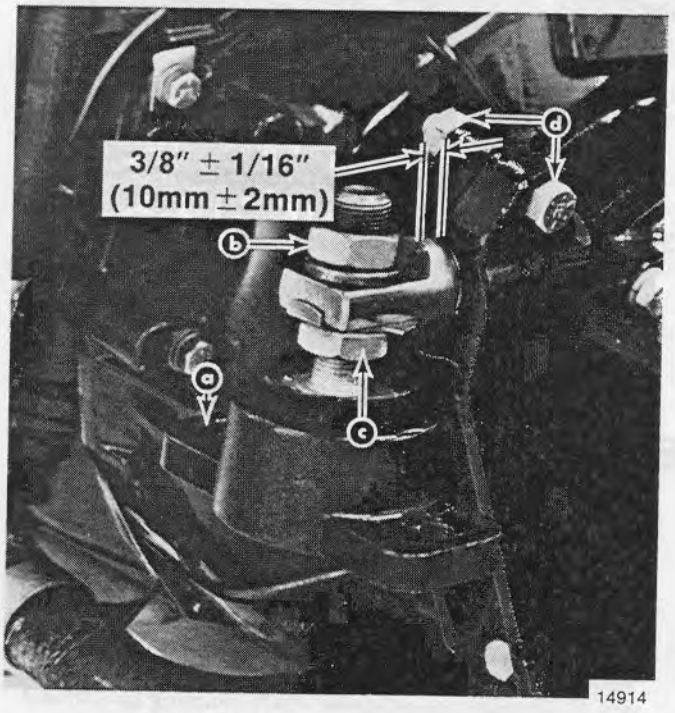


a - Bolts
b - Slot Forward

Figure 3. Engine Mounts

INSTALLATION

1. Check all 4 mounts to ensure that all mounts are:
   - In the center of their up-and-down adjustment.
   - Slot forward. (Figure 1)
   - Large diameter of mount trunnion extended as shown in Figure 1.
   - Each mount base is downward. Tighten clamping screws and nuts slightly to prevent moving in or out. Mounts MUST BE free to pivot when installing engine.



a - Slot Forward
b - Locking Nut
c - Adjusting Nut
d - Trunnion Clamping Screw and Nut

Figure 1. All 4 Mounts

2. Lift engine into boat and position on engine bed so that transmission and propeller shaft couplings are visibly aligned (no gap can be seen between coupling faces when butted together). Adjust engine bed height, if necessary, to obtain proper alignment. DO NOT use mount adjustments to adjust engine position at this time.

   NOTE: Engine bed MUST position engine so that a minimum of ¼" (6mm) up-and-down adjustment still exists on all 4 mounts after performing final alignment, following. This is necessary to allow for realigning engine in the future.

3. Check all 4 mounts to ensure that they are still positioned properly, then fasten mounts to engine bed with bolts. Tighten securely.
4. Disconnect overhead hoist and remove sling.
5. Connect fuel line. Check for leaks.
6. Connect seawater inlet hose. Tighten clamp securely.
7. Reconnect exhaust system. Tighten clamps securely.
8. Align engine as outlined in "Alignment" before completing installation.
9. After alignment is correct, connect propeller shaft coupling to transmission coupling. Torque bolts and nuts to specifications.

IMPORTANT: Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from the elbow. (Figure 2 or 3) If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn thru.

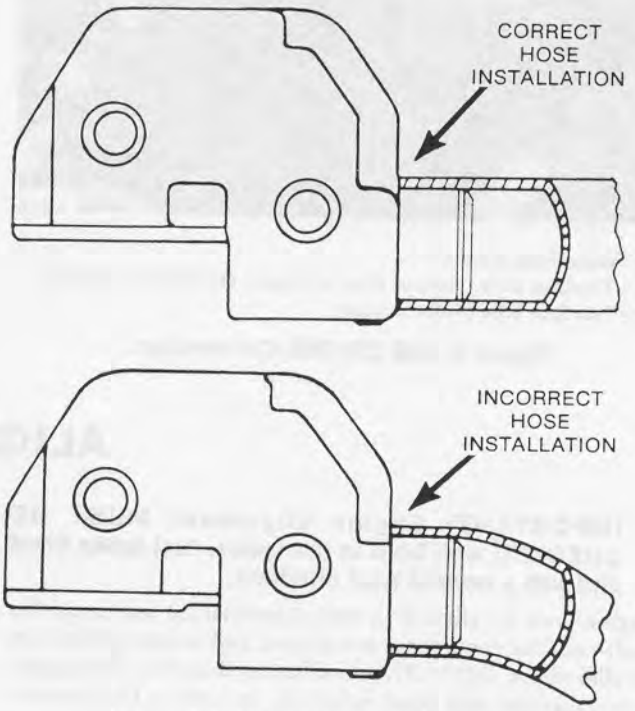


Figure 2. MIE 470/228/255/330

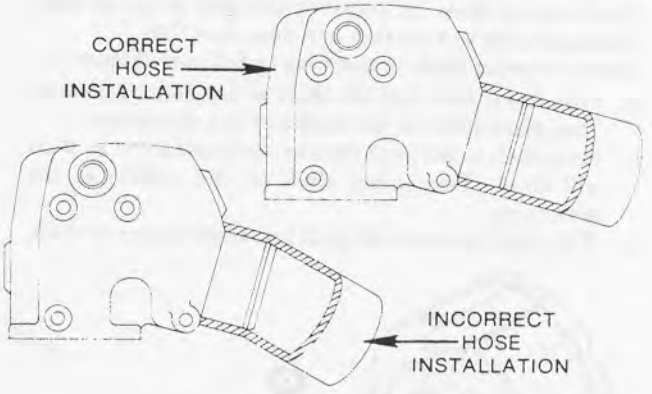
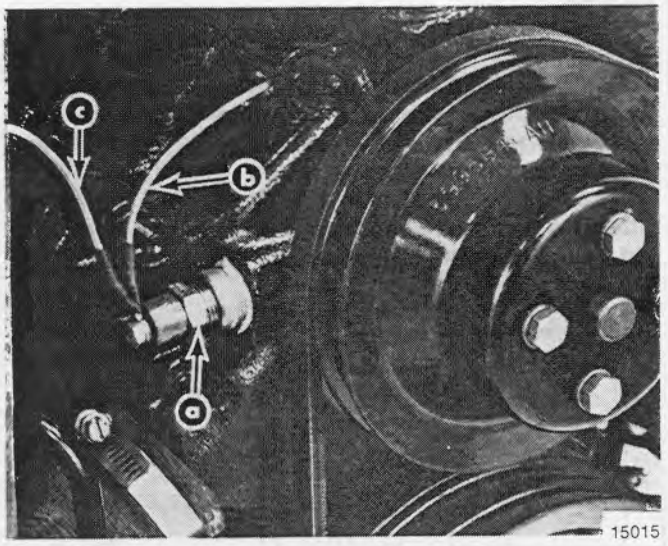


Figure 3. MIE 230/260/340

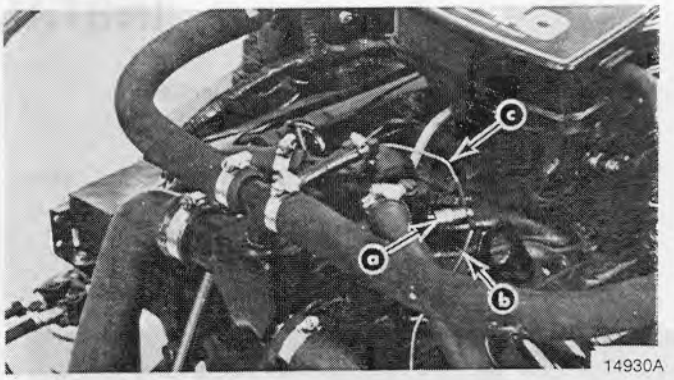
10. Connect instrument harness plug to engine harness receptacle. Tighten clmap securely.
11. Connect the shift cable and throttle cable as outlined in:
    - "Attaching/Adjusting Shift Cable".
    - "Attaching/Adjusting Throttle Cable".
12. Reconnect any ground wire and accessories that may have been disconnected.

    MIE 230/260/340: Connect audio warning system as shown in Figure 4 or 5.



a - Water Heat Switch
b - Tan/Blue Wire (Jumper Wire to Engine Oil Pressure Switch)
c - Tan/Blue Wire (From Buzzer)

Figure 4. MIE 230/260 Connection



a - Water Heat Switch
b - Tan/Blue Wire (Jumper Wire to Engine Oil Pressure Switch)
c - Tan/Blue Wire (From Buzzer)

Figure 5. MIE 340 Connection

13. Connect battery cables to battery. Tighten securely.

ALIGNMENT

IMPORTANT: Engine alignment MUST BE CHECKED with boat in the water, fuel tanks filled and with a normal load onboard.

Engine must be aligned so that transmission and propeller shaft coupling centerlines are aligned and coupling faces are parallel within .003" (.07mm). (Figures 2 and 3) This applies to installations with solid couplings, as well as flexible couplings. Engine must be properly aligned or vibration, noise and damage to transmission output shaft oil seal and bearings may result.

1. Check mating faces on transmission and propeller shaft couplings to make sure they are clean and flat.
2. Center propeller shaft in shaft log as follows: (Figure 1)
   a. Push down and then lift shaft as far as it will move. Then place shaft in the middle of the movement.
   b. Move shaft to port and then to starboard as far as shaft will move. Then place shaft in the middle of the movement.
   c. With shaft in center of shaft log, align engine to shaft.

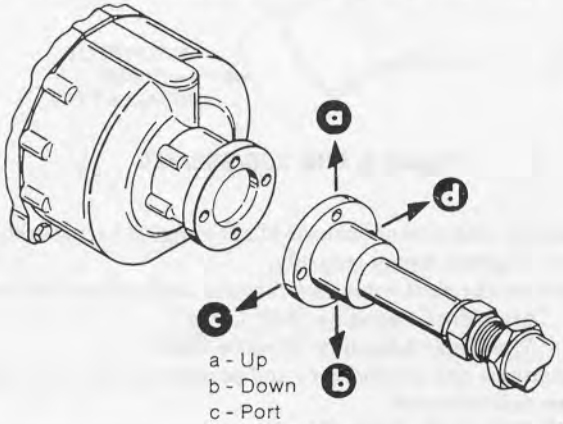


Figure 1. Centering Shaft in Shaft Log

IMPORTANT: Remote V-Drive Models: Refer to Remote V-Drive manufacturers instructions for drive shaft (between transmission and remote V-Drive) alignment.

3. Check that coupling centerlines align, by butting propeller shaft coupling against transmission coupling. (Figure 2) Shoulder on propeller shaft coupling face should engage recess on transmission coupling face with no resistance.

   NOTE: Some propeller shaft couplings may not have a shoulder on mating face. On these installations, use a straight edge to check centerline alignment. (Figure 3)

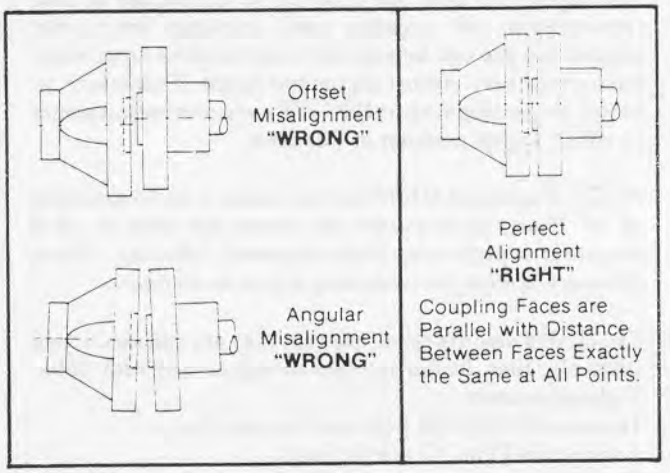


Figure 2. Coupling Alignment

4. Check for angular misalignment, by hand holding coupling faces tightly together and checking for a gap between coupling faces with a .003" (.07mm) feeler gauge at 90° intervals. (Figure 3)

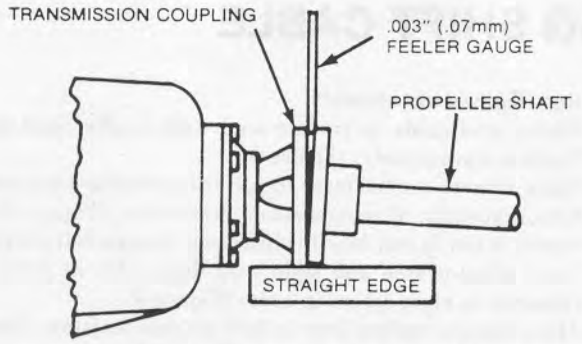
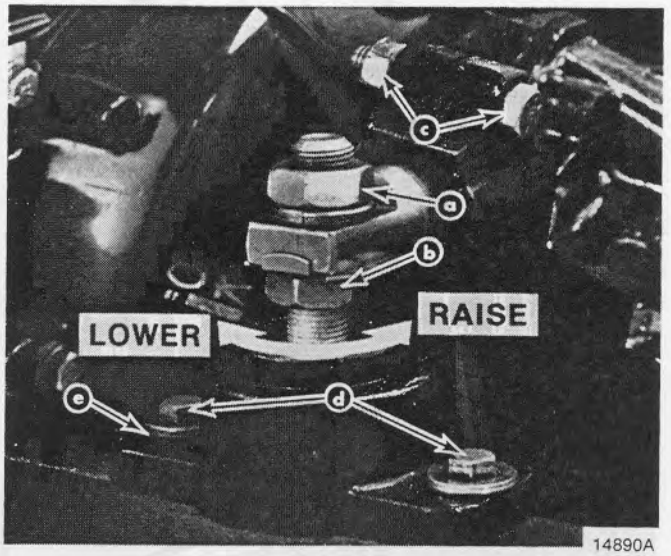


Figure 3. Checking for Coupling Angular Misalignment

5. If coupling centerlines are not aligned or if coupling faces are more than .003" out-of-parallel, adjust engine mounts, as follows:
   a. TO ADJUST ENGINE UP OR DOWN (Figure 4): Loosen locking nut on mounts requiring adjustment. Raise or lower engine using adjusting nut.

      IMPORTANT: Both front mounts must be adjusted equally and both rear mounts must be adjusted equally to keep engine level from side-to-side.



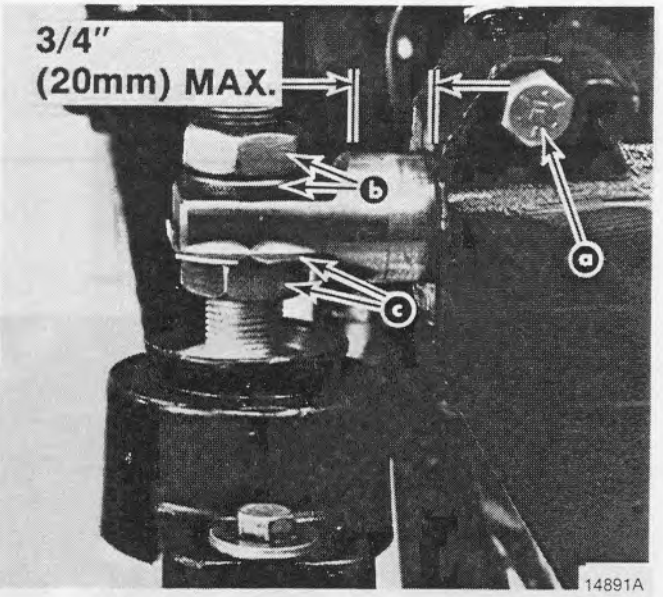
a - Locking Nut
b - Adjusting Nut
c - Clamping Screw and Nut
d - Lag Screws
e - Slot

Figure 4. Adjusting Mounts

   b. TO MOVE ENGINE TO THE LEFT OR RIGHT (Figures 4 and 5): Loosen clamping screw and nut on all 4 mount brackets and move engine to the left or right, as necessary, to obtain proper alignment. If additional right or left adjustment is needed, a small amount of adjustment can be obtained with slot on front end of mounts. Loosen lag bolts which fasten mounts to engine bed and move engine to the right or left as required. Retighten lag bolts securely.

      IMPORTANT: Large diameter of mount trunnion MUST NOT extend over ¾" (20mm) from mount brackets on any of the mounts. (Figure 5)

6. After engine has been properly aligned, secure engine mounts, as shown in Figure 5.



a - Torque Clamping Screw and Nut on All 4 Mount Brackets to Specifications
b - Tighten Locking Nut on All 4 Mounts Securely (Until Lockwasher is Compressed)
c - Bend One of the Tabs on Tab Washer Down onto Flat of Adjusting Nut, to Prevent Nut from Loosening during Operation

Figure 5. All 4 Engine Mounts

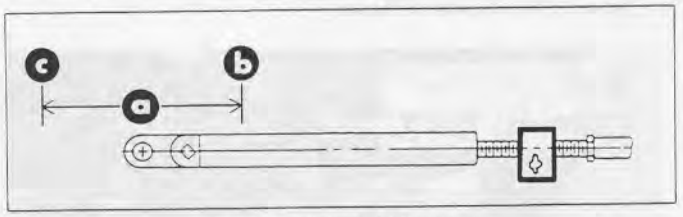
7. Connect propeller shaft coupling to transmission coupling. Torque coupling attaching screws and nuts to specifications.

ATTACHING/ADJUSTING SHIFT CABLE

MIE 470/228/255/330

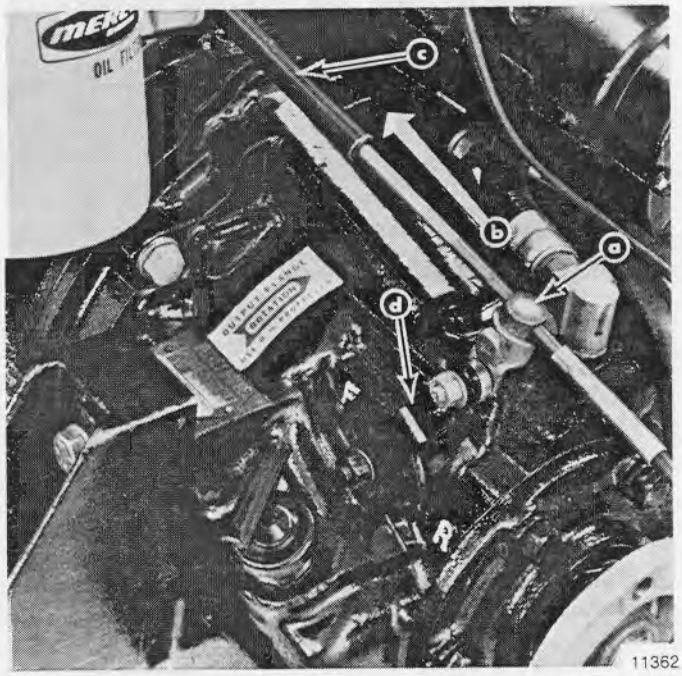
Remote control must provide a total shift cable travel (at transmission end) of at least 2¾" (70mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail. (Figure 1)

IMPORTANT: Remote control and shift cable MUST position transmission shift lever EXACTLY as shown in Figures 2 and 3, or transmission failure may occur. DO NOT remove poppet ball or spring.



a - 2-3/4" (70mm) Minimum
b - Forward Gear
c - Reverse Gear

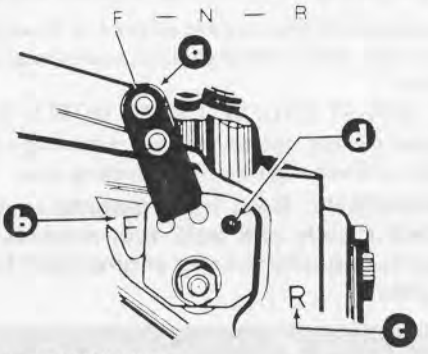
Figure 1. Total Shift Cable Movement



a - Cable Brass Barrel (Does Move, Inner Core Wire Retracts)
b - Brass Barrel MUST Move In This Direction When Remote Control is Shifted into Forward Gear Position
c - Cable End Guide (Does Not Move)
d - Transmission Shift Lever

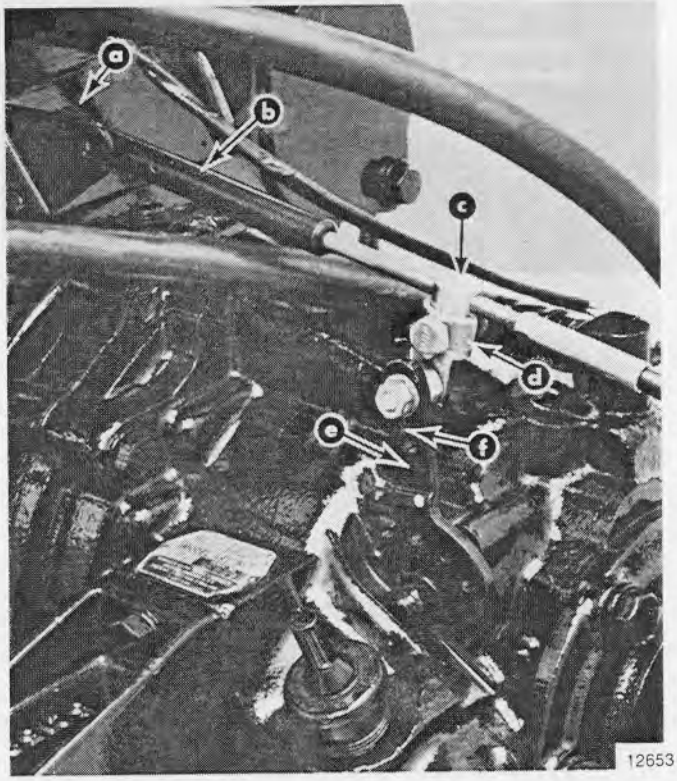
Figure 2. Shift Cable Movement

1. Place remote control lever in neutral gear position.
2. Place transmission shift lever in neutral. Lever is in neutral position when detent is in center hole of shift lever. (Figure 4)
3. Place cable end guide on anchor stud and thread barrel on cable in direction required to place hole in barrel in line with hole which is located in shift lever adaptor. (Figure 4)
4. Fasten barrel to shift lever adaptor with screw, washer and nut. Tighten nut securely.
5. Fasten end guide to anchor stud with washer and nut. Tighten nut securely. (Figure 4)
6. Move remote control lever to full forward gear position.
7. Check position of transmission shift lever. (Figure 3) If detent is not in rear hole in shift lever, loosen nut on shift lever adaptor stud and slide stud down slot in lever as required to place detent in hole. (Figure 4)
8. Move remote control lever to full reverse position. Check position of transmission lever. (Figure 3)



a - Transmission Shift Lever
b - Shift Lever MUST BE Over This Letter When Propelling Boat FORWARD
c - Shift Lever MUST BE Over This Letter When Propelling Boat IN REVERSE
d - Poppet Ball MUST BE Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)

Figure 3. Shift Lever Positions

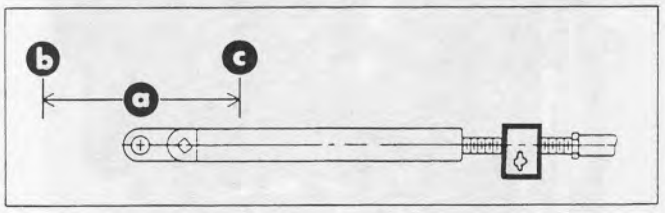


a - Anchor Stud
b - Cable End
c - Brass Barrel
d - Shift Lever Adaptor
e - Shift Lever
f - Slot

Figure 4. Shift Cable Installation

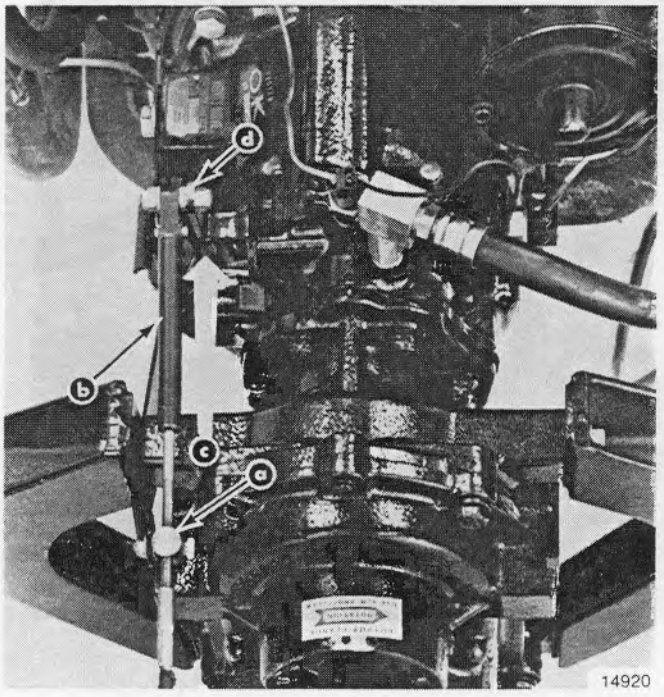
Remote control must provide a total shift cable travel (at transmission end) of at least 2¾" (70mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail. (Figure 5)

IMPORTANT: Remote control and shift cable MUST position transmission shift lever EXACTLY as shown in Figures 6 and 7, or transmission failure may occur. DO NOT remove poppet ball or spring.



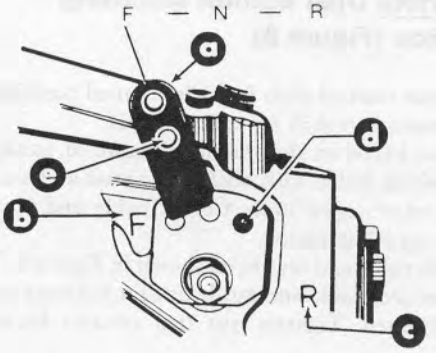
a - 2-3/4" (70mm) Minimum
b - Forward Gear
c - Reverse Gear

Figure 5. Total Shift Cable Movement



a - Cable Brass Barrel (Does Not Move)
b - Cable End Guide (Does Move, Inner Core Wire Extends)
c - Cable End Guide MUST Move In This Direction When Remote Control is Shifted into Forward Gear Position
d - Transmission Shift Lever

Figure 6. Shift Cable Movement

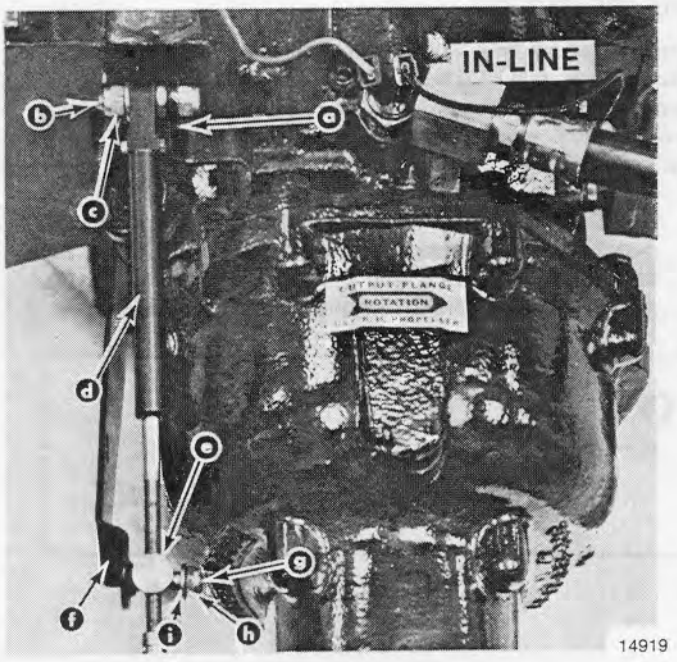


a - Transmission Shift Lever
b - Shift Lever MUST BE Over This Letter When Propelling Boat FORWARD
c - Shift Lever MUST BE Over This Letter When Propelling Boat IN REVERSE
d - Poppet Ball MUST BE Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)
e - Install Shift Lever Stud in This Hole, If Necessary, To Center Poppet Ball in Forward and Reverse Detent Holes

Figure 7. Shift Lever Positions

Models without Dual Station Mounting - Single Station (Figure 8)

1. Place remote control shift lever in neutral position.
2. Place transmission shift lever in neutral.
3. Adjust brass barrel on shift cable, as required, to align shift cable attaching holes with shift lever stud and shift cable bracket stud or screw hole. Center cable end play travel when making adjustment.
4. Install shift cable and secure as shown in Figure 8. Tighten nut that secures cable end guide until it bottoms out, then back off ½-turn. Tighten nut that secures brass barrel securely.
5. Place remote control shift lever in full forward gear position. Check position of transmission shift lever. (Figure 7)
6. Place remote control lever in full reverse gear position and again check shift lever position. (Figure 7)
7. If transmission shift lever is positioned correctly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move shift lever stud from top hole in shift lever to bottom hole ("e" in Figure 7) and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



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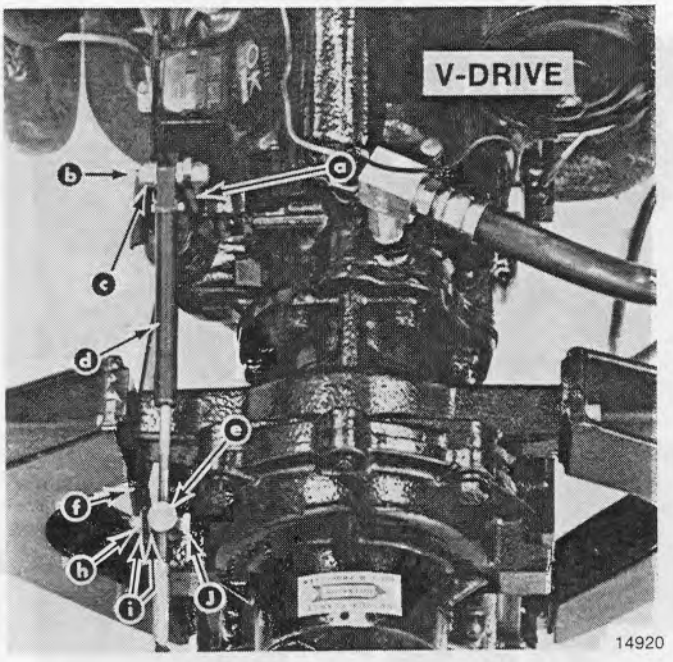

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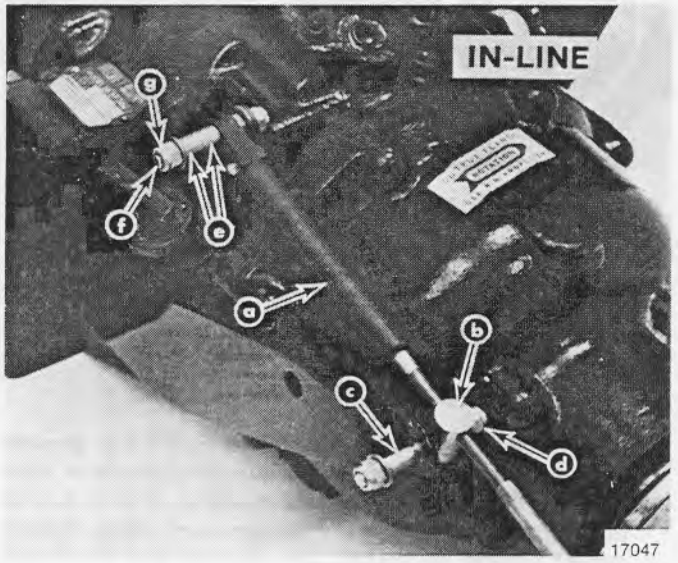
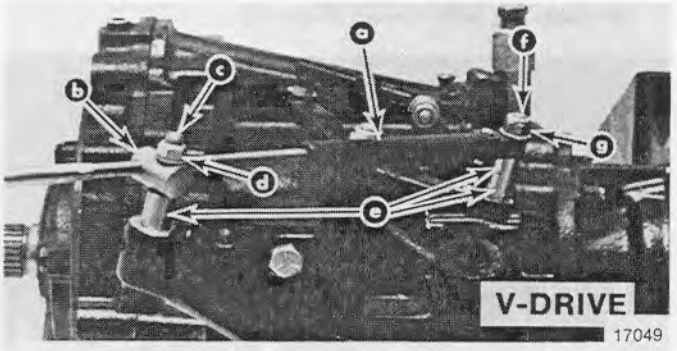
a - Shift Lever
b - Shift Lever Stud
c - Elastic Stop Nut (Thick) and Flat Washer
d - Cable End Guide
e - Cable Brass Barrel
f - Shift Cable Bracket
g - Anchor Stud (In-Line Transmission)
h - Elastic Stop Nut (Thin)
i - Flat Washer
j - Anchor Screw (V-Drive)

Figure 8. Shift Cable Installation

Models with Dual Station Mounting - Single and Dual Station (Figure 9 or 10)

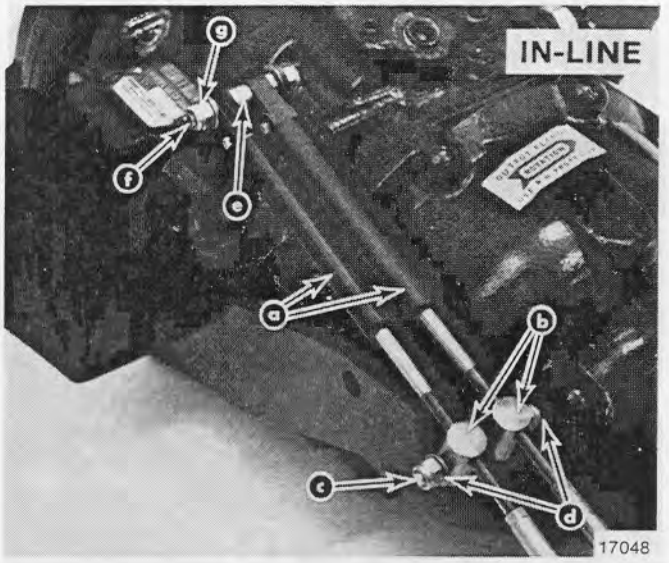
1. Place remote control shift lever in neutral position.
2. Place transmission shift lever in neutral position.
3. Adjust brass barrel on shift cable to align holes in brass barrel and cable end guide with attaching points on transmission. Center cable end play travel when making adjustment.
4. Install shift cable, as shown. Tighten "g" until it bottoms out, then back off ½-turn. Cable end guide must be free to pivot. Tighten "d" securely.
5. Place remote control shift lever in forward gear position and check position of transmission shift lever. Shift lever must be positioned as shown. (Figure 7)
6. Place remote control lever in reverse gear position and again check shift lever position. Lever must be positioned as shown in (c). (Figure 7)
7. If transmission shift lever is positioned properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move transmission shift lever stud from top hole in shift lever to bottom hole ("e" in Figure 7) and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.





a - Cable End Guide
b - Cable Brass Barrel
c - Anchor Stud
d - Elastic Stop Nut and Washer
e - Spacer
f - Shift Lever Stud
g - Elastic Stop Nut and Washer

Figure 9. Shift Cable - Single Station Installation



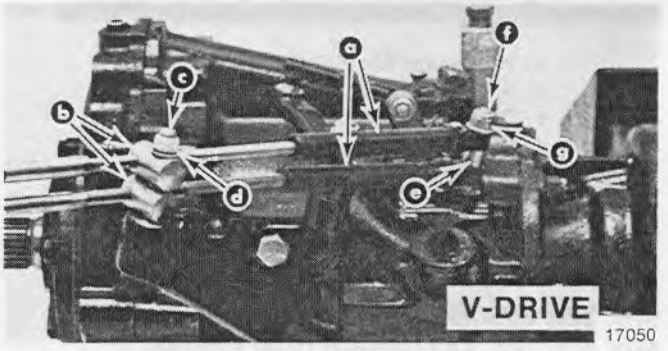
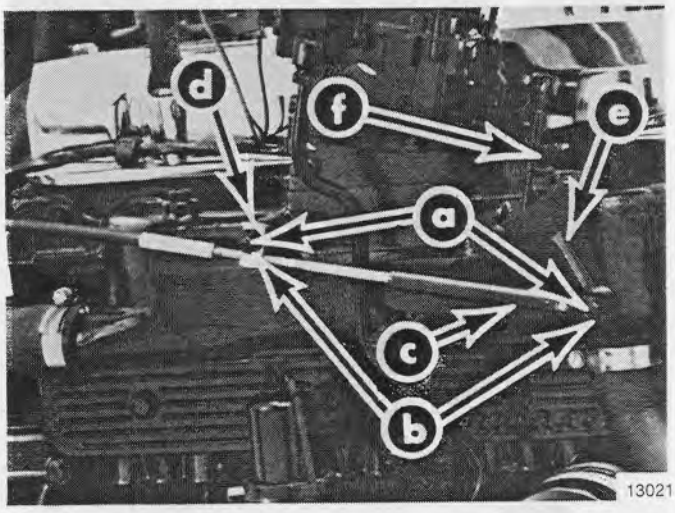


Figure 10. Shift Cable - Dual Station Installation

ATTACHING/ADJUSTING THROTTLE CABLE

MIE 470 (Figure 1)

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide to throttle lever with flat washer and nut.
3. Grasp throttle cable behind brass barrel and push cable toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel to stud with flat washer and nut.
4. Check that throttle valves are fully open when remote control is in full forward position. With throttle valves fully open, turn wide open throttle stop adjusting screw clockwise until screw just touches throttle lever. Tighten set nut securely to prevent adjustment screw from turning. Return control to neutral gear, idle position, and check that idle stop screw is against stop.

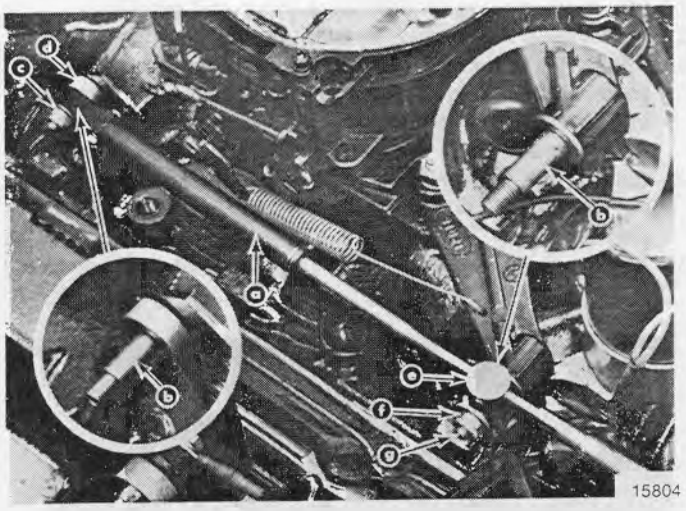


a - Washer and Nut (DO NOT Over-Tighten)
b - Anchor Stud
c - Cable End Guide
d - Brass Barrel
e - Throttle Lever
f - W.O.T. Throttle Stop

Figure 1. Throttle Cable Installation

MIE 228/255/330 (Figures 2 and 3)
MIE 230/260/340 without Dual Station Mounting - Single Station (Figures 2 and 3)

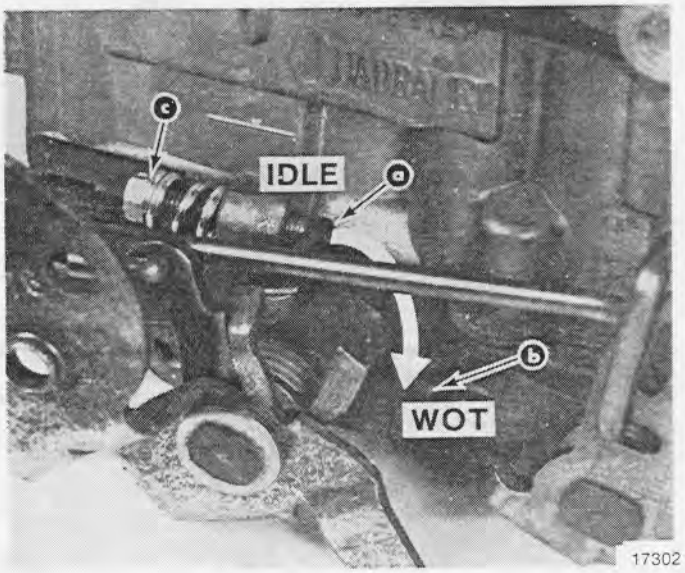
1. Place remote control lever in neutral, idle position.
2. Install throttle cable end guide on throttle lever screw. Grasp cable behind brass barrel and push LIGHTLY toward throttle lever, then adjust brass barrel to align hole with throttle cable anchor stud (and spacer) and slide barrel onto stud.
3. Secure brass barrel and cable end guide with flat washers and elastic stop nuts. Tighten cable attaching nuts securely, but do not over-tighten, because anchor points must be free to pivot.



a - Cable End Guide
b - Bushing
c - Washer, Nut and Screw (DO NOT Over-Tighten)
d - Spacer
e - Brass Barrel
f - Washer and Nut (DO NOT Over-Tighten)
g - Anchor Stud

Figure 2. Throttle Cable Installed

4. Place remote control throttle lever in the full throttle position and check that carburetor throttle plates open fully and throttle lever contacts stop. (Figure 3) If they do not, check throttle cable and linkages for binding. Return remote control to neutral, idle position and check that carburetor throttle lever returns to idle position and throttle plates are fully closed. (Figure 3)

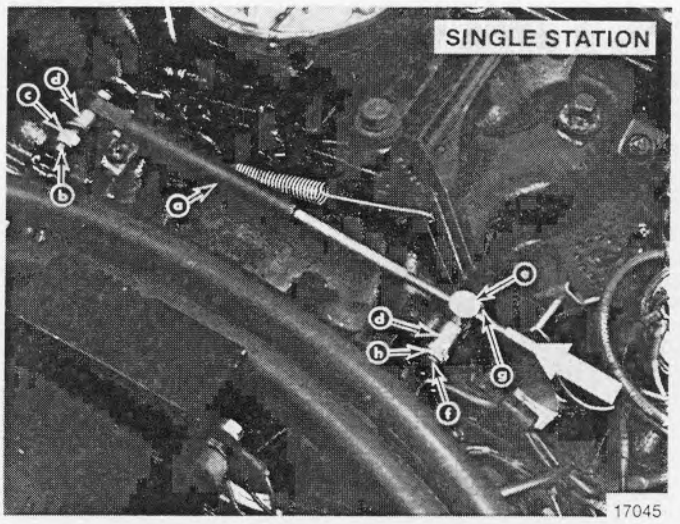


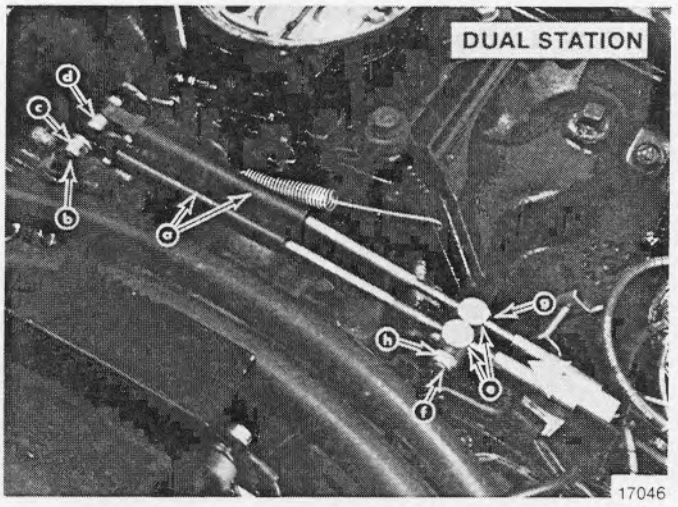
a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

Figure 3. Idle/Full Throttle Check

MIE 230/260/340 with Dual Station Mounting - Single and Dual Station (Figures 3 and 4)

1. Place remote control throttle lever in idle position and attach cable end guide to carburetor throttle lever as shown.
2. Grasp cable behind brass barrel and push lightly as shown. Adjust brass barrel to align hole with anchor stud, then slide barrel onto stud.
3. Tighten "c" and "h" securely, but do not over-tighten.
4. Place remote control throttle lever in the full throttle position and check that carburetor throttle plates open fully and throttle lever contacts stop. (Figure 3) If they do not, check throttle cable and linkages for binding. Return remote control to neutral, idle position and check that carburetor throttle lever returns to idle position and throttle plates are fully closed. (Figure 3)



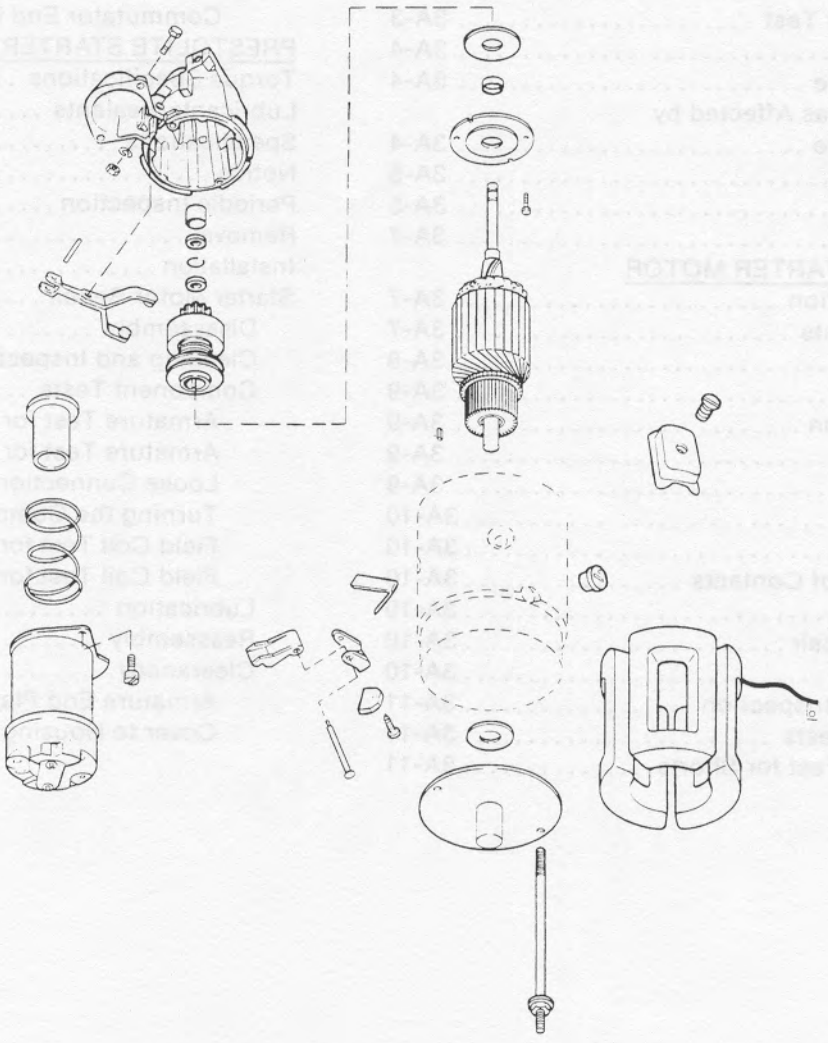


a - Cable End Guide
b - Throttle Lever Stud
c - Elastic Stop Nut and Washer
d - Spacer
e - Cable Brass Barrel
f - Anchor Stud
g - Washer
h - Elastic Stop Nut

Figure 4. Throttle Cable Installation

SECTION 3 - ELECTRICAL SYSTEM

PART A - STARTING SYSTEM



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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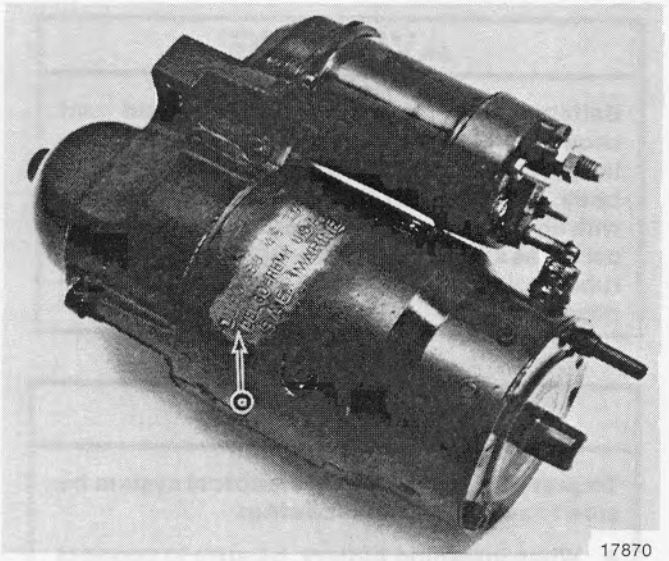
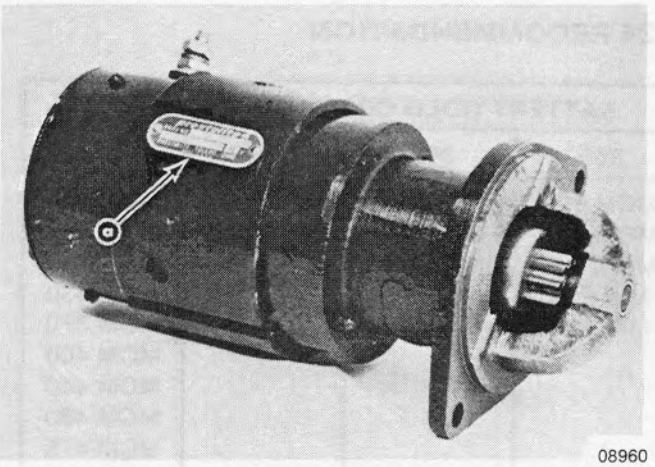
STARTER IDENTIFICATION



a - Delco Number

Figure 1. Delco-Remy Starter Motor



a - Prestolite Number

Figure 2. Prestolite Starter Motor

REPLACEMENT PARTS WARNING

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

BATTERY

SIZE RECOMMENDATION

BATTERY COLD CRANKING AMPERAGE			
305	350	375	450
MCM 120 MCM 898 MCM 228 MIE 228 MIE 230	MCM 260 MIE 255 MIE 260	MCM 140 MCM 165	MCM 470 MCM 485 MCM 488 MCM 330 MCM 370 MCM 400 MCM 440 MCM 460 MCM 475 MIE 470 MIE 330 MIE 340

CABLE SIZE

IMPORTANT: Terminals MUST BE soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder ONLY. DO NOT use acid flux solder, as it may cause corrosion and failure.

BATTERY CABLE	
Cable Length	Cable Gauge
Up to 3-1/2 Ft. (1.1m)	4 (19mm²)
3-1/2 - 6 Ft. (1.1-1.8m)	2 (32mm²)
6 - 7-1/2 Ft. (1.8-2.3m)	1 (40mm²)
7-1/2 - 9-1/2 Ft. (2.3-2.9m)	0 (50mm²)
9-1/2 - 12 Ft. (2.9-3.7m)	00 (62mm²)
12 - 15 Ft. (3.7-4/6m)	000 (81mm²)
15 - 19 Ft. (4.6-5.8m)	0000 (103mm²)
Both positive (+) and negative (-) cables	

PRECAUTIONS

⚠WARNING

Hydrogen gases that escape from the battery during charging are explosive. Be sure that battery area is well ventilated and that bilge blower is in operation when charging. DO NOT smoke or allow sources of spark or open flame in area when charging battery.

⚠WARNING

Battery electrolyte is a corrosive acid and should be handled with extreme care. If electrolyte is spilled or splashed on any part of the body, IMMEDIATELY flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible. Safety glasses and rubber gloves are recommended when handling batteries.

⚠CAUTION

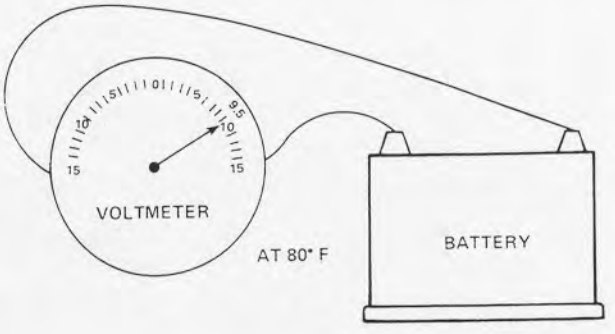
To prevent damage to the electrical system be sure to adhere to the following:

- **When installing battery, be sure to connect the (-) negative (grounded) battery cable to the (-) negative battery terminal and (+) positive battery cable to (+) positive battery terminal.**
- **Never disconnect the battery cables while the engine is running.**
- **If a charger or booster is to be used, BE SURE to connect it in parallel with existing battery (positive to positive and negative to negative).**
- **When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).**
- **Check battery condition periodically.**
- **Make sure that battery leads are kept clean and tight.**

TESTING

Load Test

A strong battery must be maintained. If battery shows less than 9½ volts when under starting load, it should be recharged. Check with DC voltmeter.



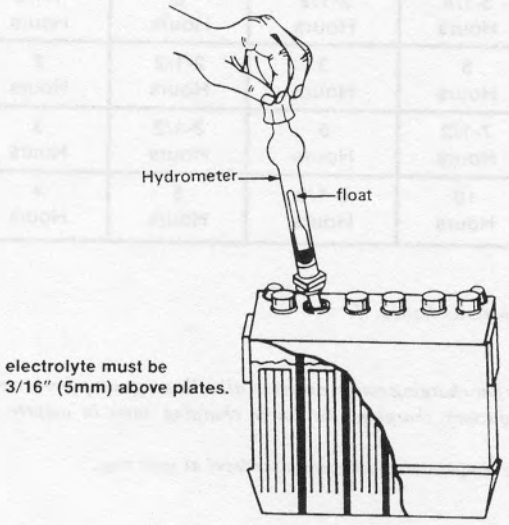
Hydrometer Test

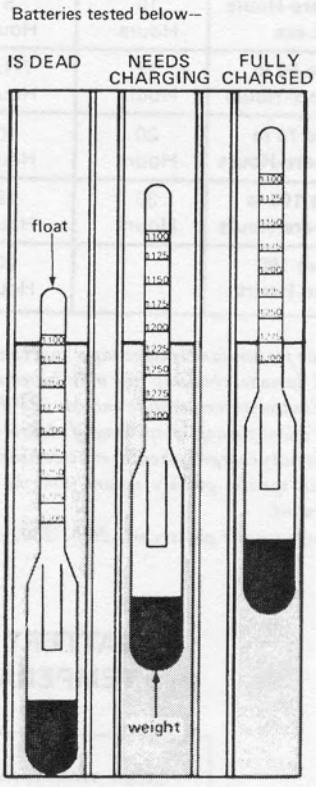
When using a hydrometer, observe the following points:

1. Hydrometer must be clean (inside and out) to insure an accurate reading.
2. Never take hydrometer readings immediately after water has been added.
3. If hydrometer has built-in thermometer, draw liquid in several times to ensure correct temperature before taking reading.
4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free-floating. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid.
5. Avoid dropping electrolyte on boat or clothing, as it is extremely corrosive. Wash off immediately with baking soda solution.

⚠WARNING

Test battery in well ventilated area as gases given off by battery are hazardous.





It is the activity of the acid (hyd. reading) which determines the activity of that cell.

Fully Charged	1.280	1.260
75% Charged	1.230	1.220
50% Charged	1.180	1.170
25% Charged	1.130	1.120
Discharged	1.080	1.070

STORAGE

- Remove battery and clean exterior.
- Check fluid level and fill if low.
- Cover terminals and bolts with light coat of grease.
- Set battery on wood or in carton, store in cool, dry place.
- Check every 20 days for fluid level and slow charge.

IMPORTANT: A discharged battery can be damaged by freezing.

CHARGING GUIDE

12 Volt Battery Recommended Rate* and Time for Fully Discharged Condition

Twenty Hour Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
50 Ampere-Hours or Less	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
Above 50 to 75 Ampere-Hours	15 Hours	7-1/2 Hours	3-1/4 Hours	2-1/2 Hours	2 Hours	1-1/2 Hours
Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2-1/2 Hours	2 Hours
Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7-1/2 Hours	5 Hours	3-1/2 Hours	3 Hours
Above 150 Ampere-Hours		20 Hours	10 Hours	6-1/2 Hours	5 Hours	4 Hours

**Initial rate for constant voltage taper rate charger*

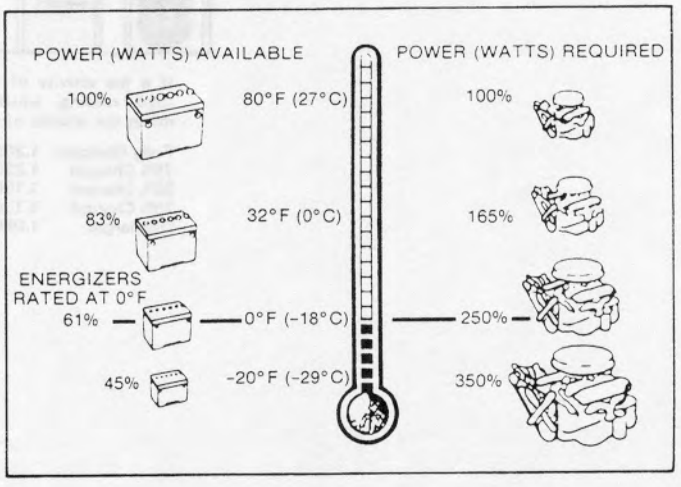
To avoid damage, charging rate must be reduced or temporarily halted, if:

1. *Electrolyte temperature exceeds 125° F (52° C).*
2. *Violent gassing or spewing of electrolyte occurs.*

Battery is fully charged when, over a two hour period at a low charging rate in amperes, all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Full charge specific gravity is 1.260-1.280, corrected for temperature with electrolyte level at split ring.

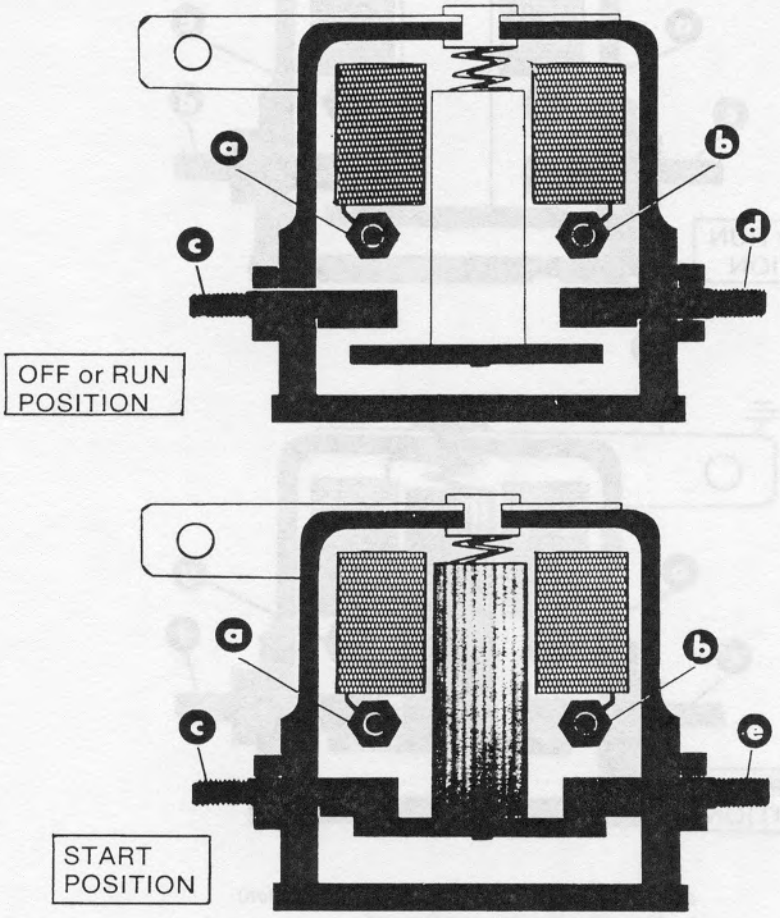
BATTERY POWER as AFFECTED by TEMPERATURE



SLAVE SOLENOIDS

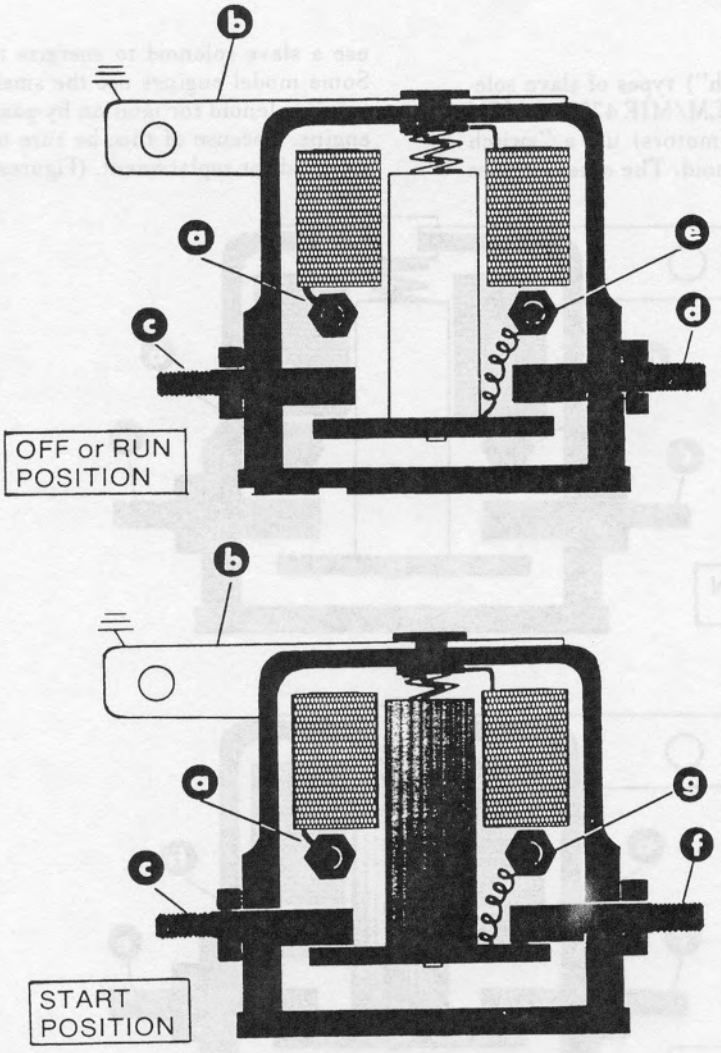
TYPES

There are two ("standard" or "switch") types of slave solenoids used on MerCruiser engines. MCM/MIE 470 and MCM 485 engines (with Prestolite starter motors) use a "switch type" slave solenoid as a starter solenoid. The other engines use a slave solenoid to energize the starter motor solenoid. Some model engines use the small terminal on the "switch type" solenoid for ignition by-pass during the starting of the engine. Because of this, be sure to use correct type of slave solenoid for replacement. (Figures 1 and 2)



a - From Key Switch (12 Volts in Start Position)
b - To Ground
c - 12 Volts From Battery
d - 0 Volts To Starter
e - 12 Volts To Starter

Figure 1. "Standard Type" Slave Solenoid



a - From Key Switch (12 Volts in Start Position)
b - Mounting Bracket and Ground
c - 12 Volts From Battery
d - 0 Volts To Starter
e - 0 Volts To Ignition Coil
f - 12 Volts To Starter
g - 12 Volts To Ignition Coil

Figure 2. "Switch Type" Slave Solenoid

TESTING

1. Disconnect battery cables, then remove all wires from solenoid terminals.
2. Remove solenoid.
3. **Standard Type (Figure 1):**
   a. Connect continuity meter to large terminals.
   b. Connect jumper wire from positive (+) terminal on 12 volt battery to "a" terminal on solenoid.
   c. Connect jumper wire from negative (–) terminal of battery to "b" terminal on solenoid.
   d. If meter does not move, replace solenoid.

   Switch Type (Figure 2):
   a. Connect continuity meter to large terminals.
   b. Connect jumper wire from positive (+) terminal on 12 volt battery to "a" terminal on solenoid.
   c. Connect jumper wire from negative (–) terminal of battery to "b" mounting bracket.
   d. If meter does not move, replace solenoid.
   e. To test ignition by-pass, move meter lead from "f" terminal to "g" terminal. If meter does not move, replace solenoid.
4. Install solenoid.
5. Reconnect wires to terminals. Tighten securely and coat with Liquid Neoprene.
6. Reconnect battery cables. Tighten securely.

DELCO-REMY STARTER MOTOR

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Starter End Cap		110 (12)
Starter to Block	50 (68)	

LUBRICANTS/SEALANTS

LUBRICANTS/SEALANTS	
92-25711	Quicksilver Liquid Neoprene
92-32447	Quicksilver Perfect Seal
	SAE 10W Oil
	SAE 20W Oil

SPECIFICATIONS

DELCO IDENTIFICATION NUMBER	ENGINE ROTATION	NO LOAD TEST					BRUSH SPRING TENSION OZ. (GRAMS)
		VOLTS	MIN. AMPS	MAX. AMPS	MIN. RPM	MAX. RPM	
1108525	R.H.	10.6	45	110	3500	6700	40-70 (1133-1984)
1108742	L.H.	10.6	45	110	3500	6700	40-70 (1133-1984)
1108755	L.H.	10.6	55	110	2800	6400	56-105 (1588-2976)
1108756	L.H.	10.6	55	100	5200	11,100	40-70 (1133-1984)
1109482	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1109484	R.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1109485	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1109488	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1109489	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1109490	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998314	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1998315	R.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1998316	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1998317	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1998318	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998404	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998460	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
PINION CLEARANCE					.010 - .140 (.25 - 3.5mm)		
COMMUTATOR END FRAME GAP					.025 MAX. (.6mm MAX.)		

L.H. = LEFT HAND ENGINE ROTATION
R.H. = RIGHT HAND ENGINE ROTATION

NOTICE

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

PERIODIC INSPECTION

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check mounting bolts for tightness.

REMOVAL

⚠WARNING

Disconnect battery cables at battery before removing starter.

1. Disconnect wires from solenoid terminals.
2. Remove starter mounting bolts.
3. Pull starter assembly away from flywheel and remove from engine.

IMPORTANT: Some starter motors may have a special shim between mounting surface. DO NOT lose this shim.

INSTALLATION

1. Place starter assembly in position and install mounting bolts. Torque fasteners to specifications.

   IMPORTANT: Install special shim (if equipped) between starter motor and block.

2. Connect wires to solenoid terminals.
3. Connect red battery cable to large solenoid terminal and install boot over terminal (if equipped).
4. Connect battery cables to battery.

a - Large Terminal
b - Fuse (If Equipped)
c - Boot (If Equipped, Place Over Terminal)
d - Positive (+) Battery Cable
e - Negative (-) Battery Cable

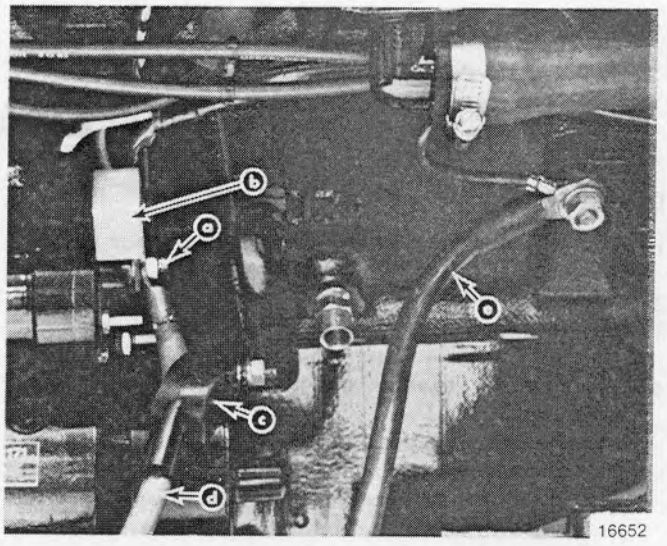


Figure 1. Typical Starter Motor

SOLENOID

REMOVAL

1. Remove starter motor as outlined.
2. Remove screw and washer from starter motor connector strap terminal.
3. Remove 2 screws which hold solenoid assembly to starter motor end frame.
4. Twist solenoid clockwise to remove flange key from keyway slot (located in starter motor), then remove solenoid assembly.

REPLACEMENT of CONTACTS

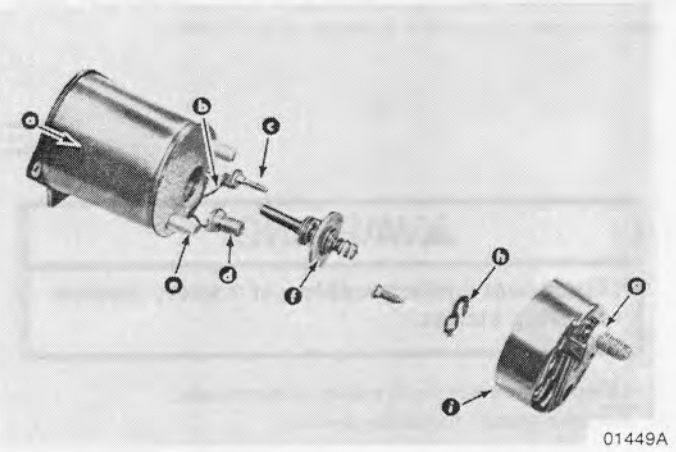
1. Remove nuts and washers from switch ("S") terminal and starter motor connector strap terminal. (Figure 2)
2. Remove 2 solenoid end cover retaining screws and washers and remove end cover.
3. Remove nut and washer from battery terminal on end cover and remove battery terminal.

IMPORTANT: DO NOT cut starter motor connector strap terminal wire to remove terminal, or wire will be too short.

4. Remove motor connector strap terminal and solder new terminal in position.
5. Remove and install new battery terminal, washer and retaining nut.
6. Install new contact ring and push rod assembly.
7. Position end cover over switch and motor terminals and install end cover retaining screws. Also install washers and nuts on solenoid switch and starting motor terminals.

INSTALLATION

1. Install solenoid return spring on plunger.
2. Position solenoid assembly to starter motor and turn solenoid to engage flange key in keyway slot.
3. Install 2 screws which hold solenoid assembly to end frame.
4. Secure starter motor connector strap terminal with screw and washer.
5. Install starter motor as outlined.



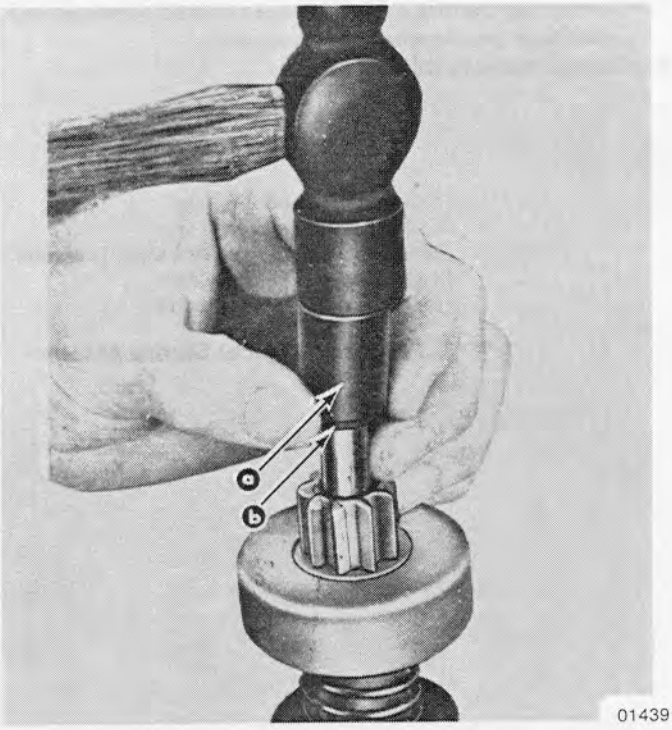
a - Solenoid Body
b - To Hold in Coil
c - Switch Terminal
d - Motor Connector Strap
e - To Pull in Coil
f - Contact Ring & Rod
g - Battery Terminal
h - Contact Finger
i - End Cover

Figure 2. Exploded View of Solenoid

STARTER MOTOR REPAIR

DISASSEMBLY

1. Remove screw and washer which fasten motor field coil connector to solenoid terminal.
2. Remove thru bolts.
3. Remove commutator end frame, field frame assembly and armature assembly from drive housing.
4. Remove over-running clutch from armature shaft as follows:
   a. Slide thrust collar off of armature shaft.
   b. Slide standard ½" pipe coupling or other metal cylinder of correct size onto shaft. (Figure 3) Tap end of coupling with hammer, driving retainer toward armature.
   c. Remove snap ring from groove.
   d. Slide retainer and clutch assembly from armature shaft.
5. Disassemble brushes and related parts from field frame as follows:
   a. Remove pin, which passes thru brush support and brush holders, and remove.
   b. Disconnect leads from brushes.



a - Cylinder
b - Retainer

Figure 3. Driving Off Retainer

CLEANING and INSPECTION

IMPORTANT: DO NOT use grease dissolving solvents for cleaning electrical components and bushings of starter motor. Such a solvent would damage insulation and remove lubricating qualities from bushings.

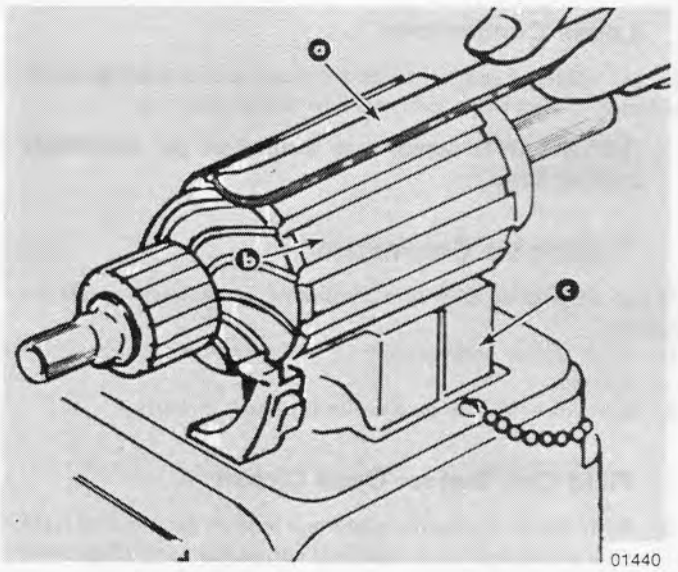
With starting motor completely disassembled (except for removal of field coils), component parts should be cleaned and inspected. Field coils should be removed only where defects are indicated by tests. Defective parts should be replaced or repaired.

1. Clean all starting motor parts but do not use dissolving solvents for cleaning over-running clutch, armature and field coils. Such a solvent would dissolve grease packed in clutch mechanism and damage armature and field coil insulation.
2. Test over-running clutch action. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace, if necessary.
3. Check that brush holders are not damaged or bent and will hold brushes against commutator.
4. Check brushes. Replace if pitted or worn to one-half their original length [5/16" (8mm) or less].
5. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly. Replace bushing, if worn, Apply SAE 20 oil to this bushing before reassembly. Avoid excessive lubrication.
6. Check fit of bushing in commutator end frame. If bushing is damaged or worn excessively, replace end frame assembly. Apply SAE 20 oil to this bushing before reassembly. Avoid excessive lubrication.
7. Inspect armature commutator. If rough or out-of-round, turn down and undercut. Inspect points (where armature conductors join commutator bars) for good, firm connection. Burned commutator bar usually is evidence of poor connection.

COMPONENT TESTS

Armature Test for Shorts

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. (Figure 4) If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.

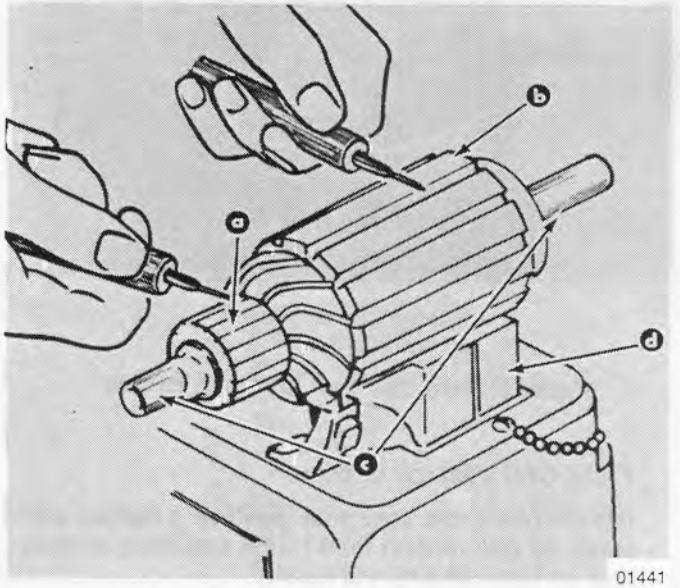


a - Hacksaw Blade
b - Armature Core
c - Growler

Figure 4. Armature Tests for Shorts

Armature Test for Ground

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand moves to right, armature is grounded and must be replaced. (Figure 5)



a - Commutator
b - Armature Core
c - Shaft
d - Growler

Figure 5. Armature Test for Ground Field Coil

Loose Connections

If open soldered connection of armature to commutator leads is found during inspection, resolder with rosin flux.

IMPORTANT: Never use acid flux on electrical connections.

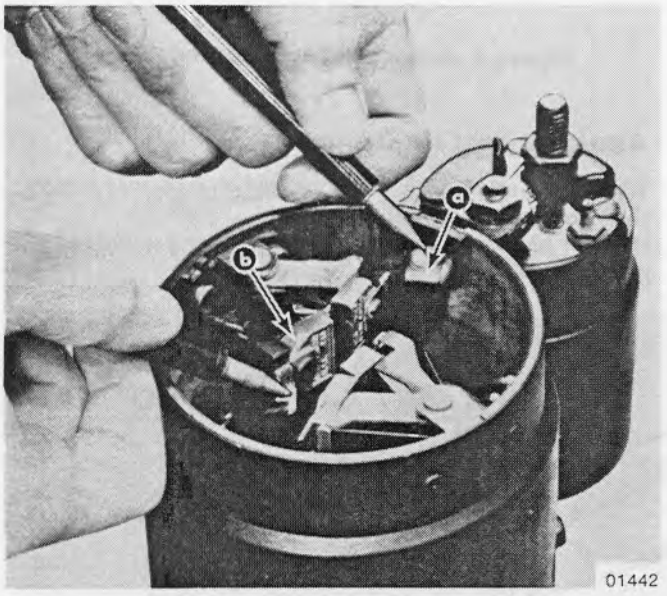
Turning the Commutator

When inspection shows commutator roughness, clean as follows:

1. Turn down commutator in a lathe until thoroughly cleaned.
2. Recheck armature on growler for short circuits.

Field Coil Test for Open Circuit

1. With continuity meter, place one lead on each end of field coils (insulated brush and field connector bar). (Figure 6)
2. If meter hand does not move to right, field coils are open and must be replaced.



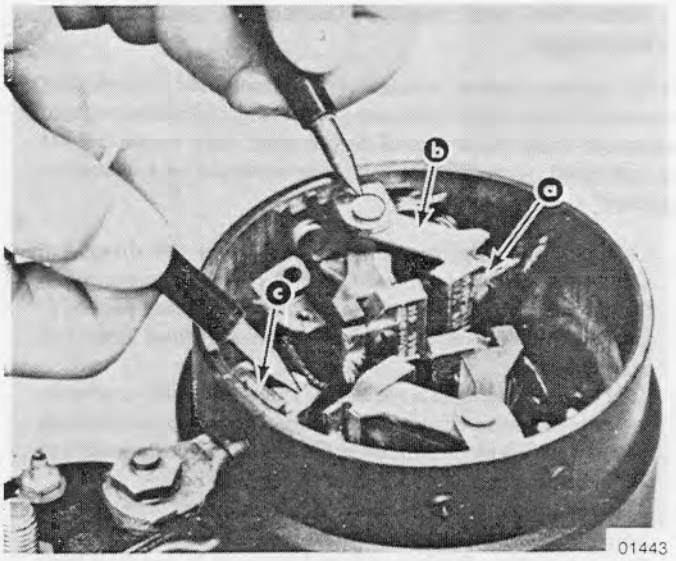
a - Field Connector Bar
b - Insulated Brush

Figure 6. Field Coil Test for Open Circuit

Field Coil Test for Ground

IMPORTANT: Be sure that positive brushes and leads do not contact field frame assembly during test, or false reading will result.

1. With continuity meter, place one lead on field connector bar and other lead on grounded brush. (Figure 7)
2. If meter hand moves to right, field coils are grounded and must be replaced.



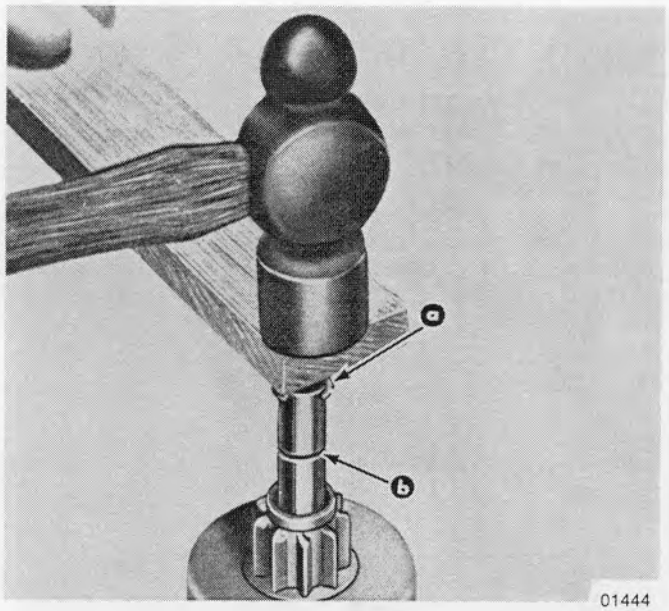
a - Grounded Brush b - Brush Holder c - Field Connector Bar

Figure 7. Field Coil Test for Ground

REASSEMBLY

After all parts are thoroughly tested and inspected and worn or damaged parts replaced, reassemble starter as follows:

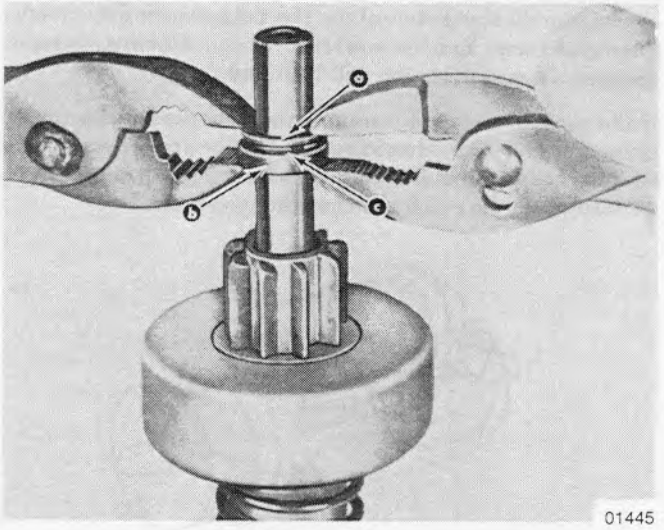
1. Assemble brushes and related parts to field frame as follows:
   a. Assemble brushes to brush holders.
   b. Assemble insulated and grounded brush holders together with "V" spring. Position as a unit and install support pin. Push holders and spring to bottom of support and rotate spring to engage center of "V" spring in slot of support.
   c. Attach ground wire to grounded brush and field lead wire to insulated brush.
2. Assemble over-running clutch assembly to armature shaft as follows:
   a. Lubricate drive end of armature shaft with SAE 10 oil.
   b. Slide assist spring and clutch assembly onto armature shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. (Figure 8) Slide snap ring down into groove.



a - Snap Ring
b - Groove

Figure 8. Forcing Snap Ring over Shaft

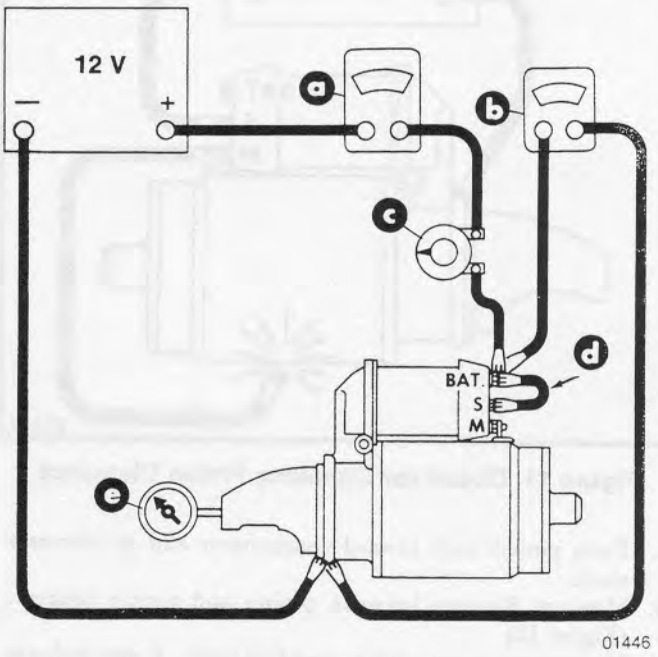
e. Assemble thrust collar on shaft with shoulder next to snap ring.
f. Position retainer and thrust collar next to snap ring. Then, using 2 pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer. (Figure 9)



a - Thrust Collar
b - Retainer
c - Snap Ring

Figure 9. Forcing Snap Ring into Retainer

3. Place 4 or 5 drops of SAE 10 oil in drive housing bushing. Slide armature and clutch assembly into place in drive housing while engaging shift lever with clutch.
4. Position field frame over armature and apply Liquid Neoprene between frame and solenoid case, observing caution to prevent damage to brushes.
5. Place 4 to 5 drops of SAE 10 oil in bushing in commutator end frame. Place leather brake washer on armature shaft and slide commutator end frame onto shaft.
6. Install solenoid as outlined.
7. After reassembly, a "no load" check of starting motor may be made if equipment is available. To check, connect starter motor in series with a fully-charged 12-volt battery, an ammeter capable of reading several hundred amperes and a variable resistance.
8. Also, connect a voltmeter, as illustrated, from motor terminal to motor frame. An RPM indicator is necessary to measure armature speed. (Figure 10) Obtain specified voltage by varying resistance unit. Then read current draw and armature speed and compare these readings with specifications.



a - Ammeter
b - Voltmeter
c - Variable Resistor
d - Jumper Lead
e - RPM Indicator

Figure 10. No Load Test Hookup

CLEARANCES

Pinion Clearance

Pinion clearance must be checked after reassembly of motor to insure proper adjustment.

1. Disconnect motor field coil connector from solenoid motor terminal and insulate it carefully.
2. Connect 12-volt battery from solenoid switch terminal to solenoid frame. (Figure 11)
3. Momentarily touch a jumper lead from solenoid motor terminal to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.

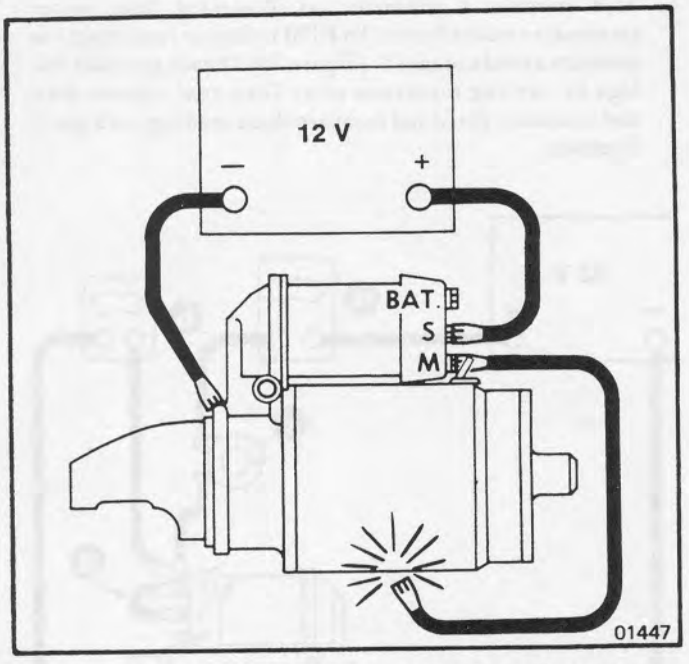
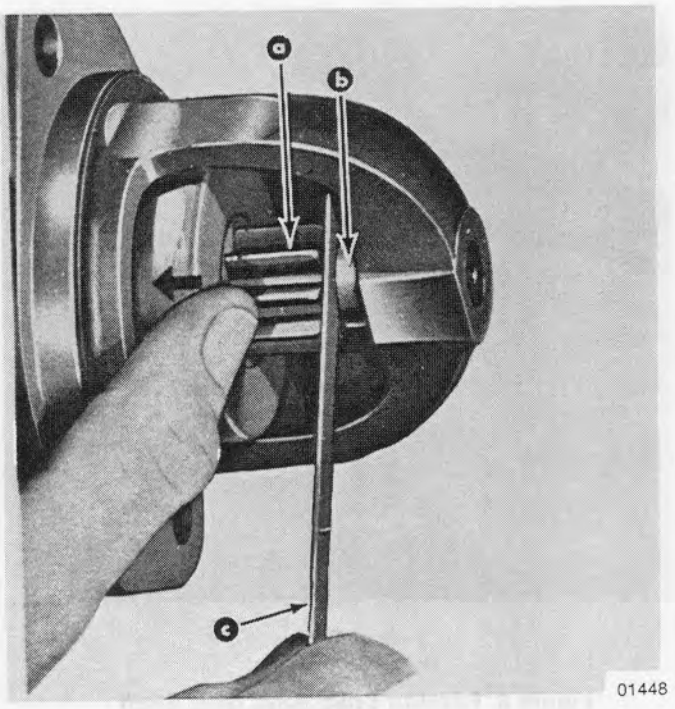


Figure 11. Circuit for Checking Pinion Clearance

4. Push pinion back toward commutator end to eliminate slack.
5. Measure distance between pinion and pinion retainer. (Figure 12)
6. If clearance is not within specified limits, it may indicate excessive wear of solenoid linkage, shift lever yoke buttons, or improper assembly of shift lever mechanism. Replace worn or defective parts, since no provision is made for adjusting pinion clearance.



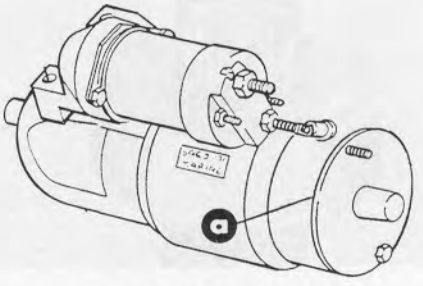
a - Pinion
b - Retainer
c - Feeler Gauge

Figure 12. Checking Pinion Clearance

Commutator End Frame Gap

In order to maintain the ignition-proof characteristics designed into the starter for safety, the gap between the commutator end frame and the starter field coil housing must be checked. Generally, no gap will be found.

If the gap exceeds specifications, when checked with a feeler gauge, the end frame should be checked for proper seating on the field coil housing. If properly seated and still found to have excessive gap, the end frame must be replaced.



a - Check End Frame Gap Here

Figure 13.

PRESTOLITE STARTER MOTOR

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Starter Through Bolts		50 (5)
Starter to Block	60 (81)	

LUBRICANTS/SEALANTS

LUBRICANTS/SEALANTS	
92-25711	Quicksilver Liquid Neoprene
92-32447	Quicksilver Perfect Seal
	SAE 10W Oil
	SAE 20W Oil

SPECIFICATIONS

IDENTIFICATION NUMBER MERCURY (PRESTOLITE)	ENGINE ROTATION	NO LOAD TEST					BRUSH SPRING TENSION OZ. (GRAMS)
		VOLTS	MIN. AMPS	MAX. AMPS	MIN. RPM	MAX. RPM	
50-72550A1 (MHA-7016)	L.H.	11	N/A	70	5500	N/A	32-40 (910-1133)
50-88671A1 (MHA-7020)	R.H.	11	N/A	70	5500	N/A	32-40 (910-1133)
ARMATURE END PLAY		.005" - .030" (.15 - .75mm) MAX.					
BEARING COVER CLEARANCE		.012" (.3mm) MAX.					

L.H. = LEFT HAND ENGINE ROTATION
R.H. = RIGHT HAND ENGINE ROTATION

NOTICE

The cranking motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

PERIODIC INSPECTION

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

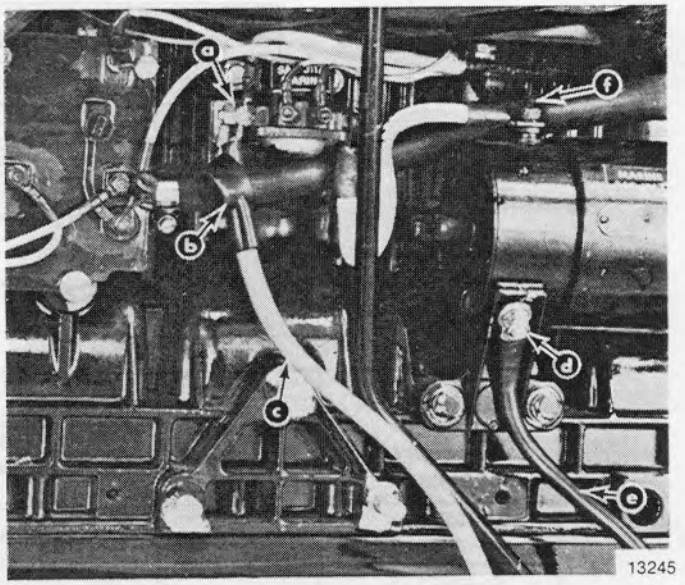
1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check mounting bolts for tightness.

REMOVAL

⚠WARNING

Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.
2. Disconnect starter cable at starter terminal and ground cable from starter mounting stud. (Figure 1)
3. Remove starter mounting bolts. (Figure 1)
4. Remove starter from engine.



a - Starter Solenoid Front Terminal
b - Rubber Boot (if Equipped)
c - Positive (+) Battery Cable
d - Starter Motor Support Bracket Stud
e - Negative (-) Battery Cables
f - Starter Terminal

Figure 1. Starter Terminal

INSTALLATION

1. Place starter motor in position on engine and install starter mounting bolts. Torque fasteners to specifications.
2. Connect battery ground cable to starter mounting bolt and yellow cable from starter solenoid to starter terminal. (Figure 1)
3. Connect battery cables to battery.

STARTER MOTOR REPAIR

DISASSEMBLY

1. Remove 2 thru bolts and cover assembly from commutator end of starter motor.
2. Remove starter housing from armature and end frame assembly.
3. Remove 2 screws, which hold intermediate bearing assembly to end frame assembly, and remove end frame assembly.
4. Remove pin and bendix drive assembly and intermediate bearing assembly from armature shaft.

IMPORTANT: DO NOT perform Steps 5, 6 and 7, unless replacement of those parts is necessary.

5. Remove 3 screws and brush plate assembly. Springs and brushes may be removed if needed.
6. Disconnect field wire from terminal stud and remove 4 screws, field assembly and pole shoes.
7. Remove nuts and remove terminal stud package.

CLEANING and INSPECTION

IMPORTANT: DO NOT use grease dissolving solvents for cleaning electrical components and bushings of starter motor. Such a solvent would damage insulation and remove lubricating qualities from bushings.

1. Use a brush or compressed air to clean field coils, armature, commutator, brushes and bushings. Wash all other parts in solvent and dry parts with compressed air.
2. Check armature visually for mechanical defects, such as worn or bent shaft, worn commutator, scored core laminations or unsoldered connections.
3. If commutator is rough, burned, out-of-round or has high mica, turn it down.
4. Test armature for short and ground.
5. Inspect armature shaft and bearings for scoring and excessive wear.
6. If brushes are oil soaked or worn to less than ¼" (6mm), they should be replaced.
7. Check brush spring tension during reassembly.
8. Visually inspect field coils for burned or broken insulation. Also check fields for opens and ground.
9. Examine wear pattern on starter drive teeth. Pinion teeth must penetrate to depth greater than ½ ring gear tooth depth on flywheel. This is necessary to eliminate premature ring gear and starter drive failure.
10. Replace starter drives and ring gears with milled, pitted or broken teeth or those which show evidence of inadequate engagement.

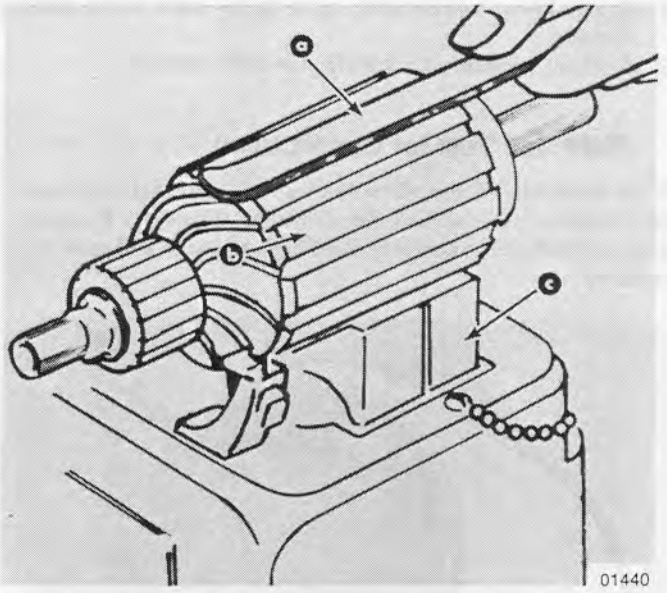
a - Core
b - Commutator
c - Shaft
d - Growler

Figure 3. Armature Test for Ground

COMPONENT TESTS

Armature Test for Shorts

Check armature for short circuits by placing armature on growler and holding hacksaw blade over core while rotating armature. (Figure 2) If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck armature on growler. If saw blade still vibrates, replace armature.

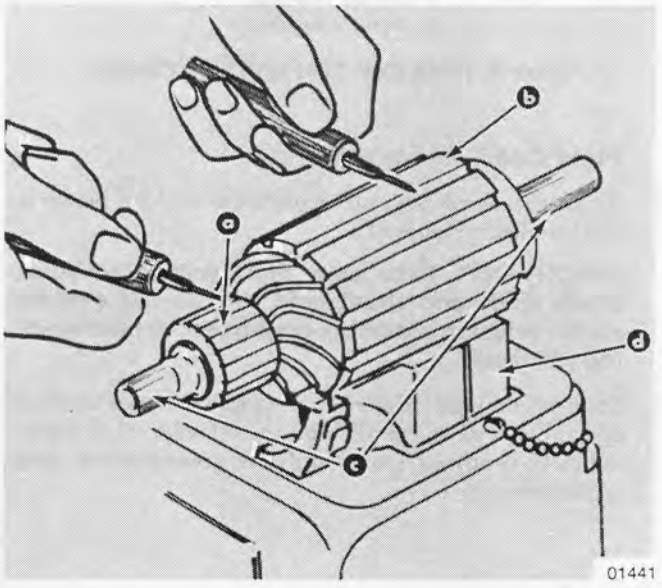


a - Hacksaw Blade
b - Armature Core
c - Growler

Figure 2. Armature Test for Shorts

Armature Test for Ground

1. With continuity meter, place one lead on armature core or shaft and other lead alternately on commutator segments.
2. If meter indicates continuity, armature is grounded and must be replaced. (Figure 3)



Loose Connections

If open soldered connection of armature to commutator leads is found during inspection, resolder with rosin flux.

IMPORTANT: Never use acid flux on electrical connections.

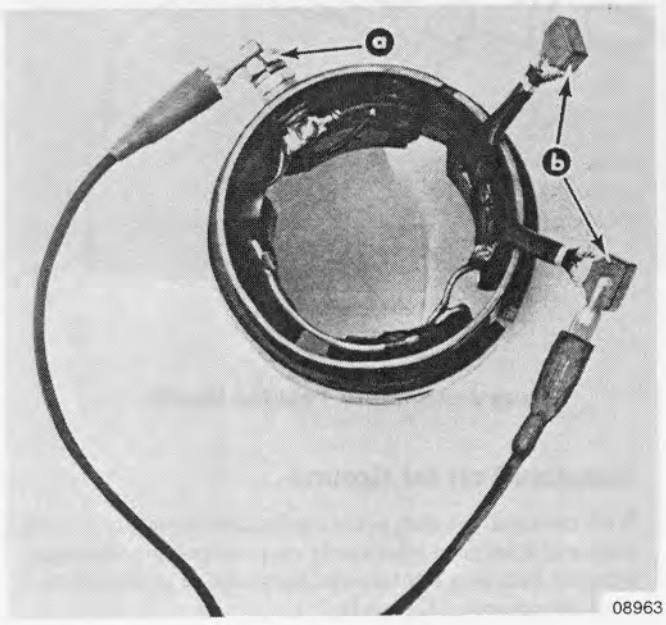
Turning the Commutator

When inspection shows commutator roughness, clean as follows:

1. Turn down commutator in a lathe until thoroughly cleaned.
2. Recheck armature on growler for short circuits.

Field Coil Test for Open Circuit

With continuity meter, place one lead on starter terminal and other lead to positive (insulated) brush. (Figure 4) If meter does not indicate continuity, field coils are open and must be replaced.



a - Starter Terminal
b - Positive Brushes

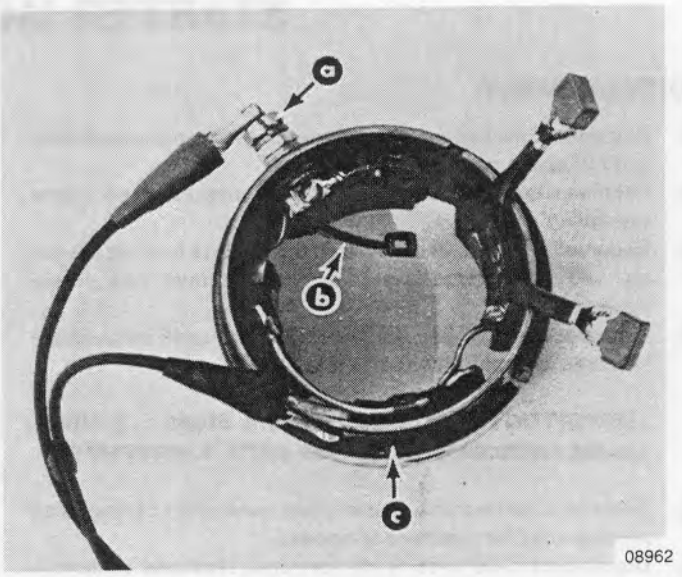
Figure 4. Field Coil Test for Open Circuit

Field Coil Test for Ground

1. Disconnect shunt field wire from brush holder if holder is still installed. (Figure 5)

   IMPORTANT: Take care that positive brushes, brush leads and shunt field wire do not contact starter housing assembly during test, or false reading will result.

2. Connect continuity meter, with one lead to starter terminal and other lead to starter housing. (Figure 5) If meter indicates continuity, field coils are grounded and need replacement.



a - Starter Terminal
b - Shunt Field Wire
c - Starter Housing

Figure 5. Field Coil Test for Ground

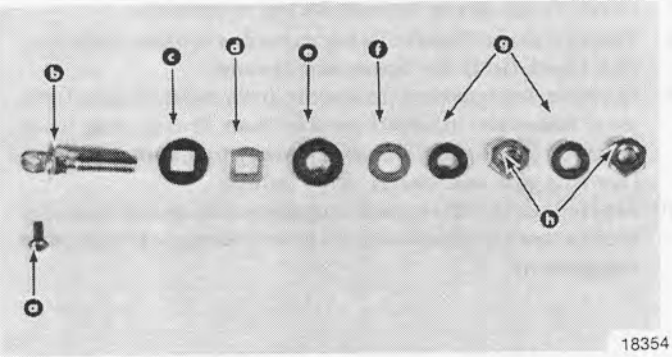
LUBRICATION

Periodic lubrication of starting motor is not required; however, during reassembly of starter motor (especially if parts have been cleaned), bearings should be soaked in SAE 10 oil. Also, lubricate drive end of armature shaft sparingly with a film of SAE 10 oil.

REASSEMBLY

IMPORTANT: If brush plate assembly, field windings and terminal stud package have not been removed, start reassembly at Step 4.

1. Install terminal stud package in sequence shown in Figure 6. Check with continuity meter to be sure that stud is insulated from starter housing.



a - Screw
b - Stud
c - Insulating Washer
— Inside of Starter Housing
d - Starter Housing Insulator
e - Insulating Washer
f - Flat Washer
g - Lockwasher (2)
h - Nut (2)
— Outside of Starter Housing

Figure 6. Terminal Stud Package

2. Place field windings and pole shoes in starter housing. Install 4 screws thru starter housing and into poles. Tighten screws securely.
3. Place brush plate assembly in position and install 3 screws and lockwashers thru starter housing and into plate assembly. Install shunt ground wire to brush plate assembly. Install brush springs.
4. Lubricate bearing surface of intermediate bearing assembly and install assembly on armature shaft. Lubricate drive end of armature shaft sparingly with a film of SAE 10 oil. Place bendix drive assembly on shaft and install roll pin.
5. Lubricate bearing (located in end frame assembly) and install armature assembly into end frame. Install 2 screws and lockwashers thru intermediate bearing assembly and into end frame. Tighten securely.
6. Position armature assembly in starter housing.
7. Check brush spring tension. Measure with scale hooked under brush spring near brush. Pull on line parallel to face of brush and take reading just as spring leaves brush. Tension must be within specifications.
8. Lubricate bearing in cover assembly and position cover on armature shaft and starter housing. Insert thru bolts and torque to specifications.

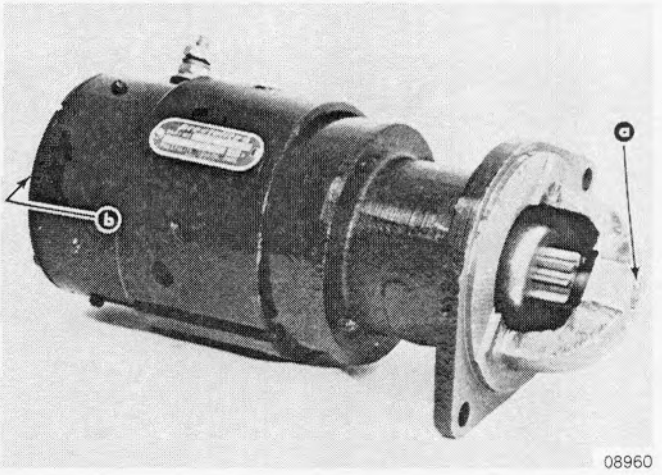
CLEARANCES

Armature End Play

Check armature shaft end play. Clamp starter motor in vise. Use dial indicator on end of armature shaft. (Figure 7) Move shaft to one end of starter housing. Zero dial indicator. Move shaft to other end of housing. Reading must fall within specifications. To correct end play, use different thickness thrust washer on armature shaft.

Cover to Housing

Check clearance between cover and housing assembly. (Figure 7) Clearance must not exceed specifications. If found excessive, check seating of cover onto housing. If properly seated, and excessive gap remains, replace cover.

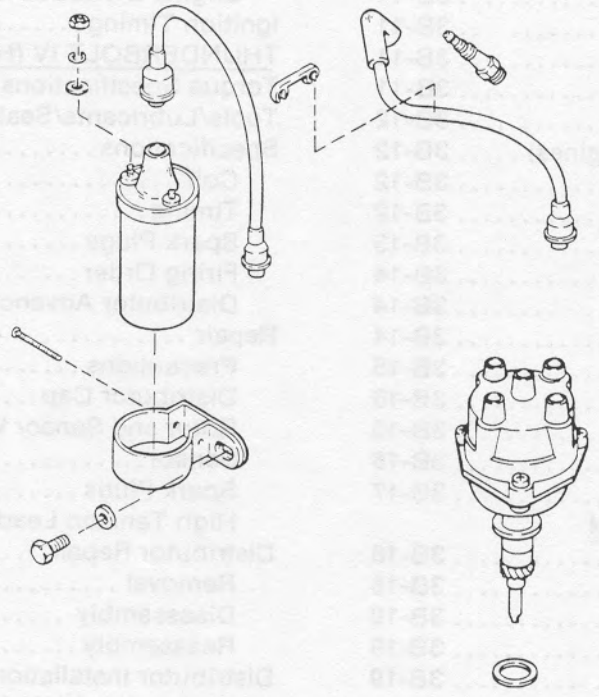


a - Armature Shaft
b - Check Cover Clearance

Figure 7. Clearances

SECTION 3 - ELECTRICAL SYSTEM

PART B - IGNITION SYSTEM



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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IDENTIFICATION

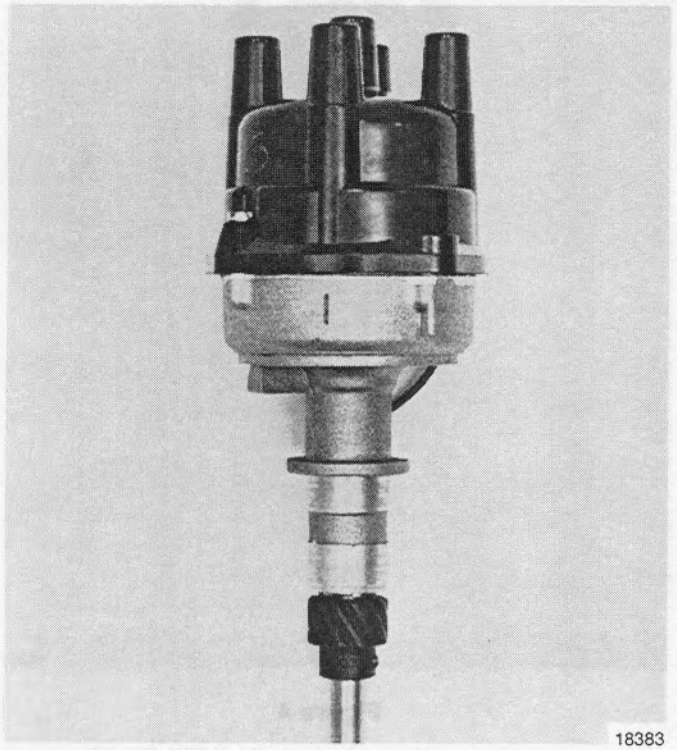
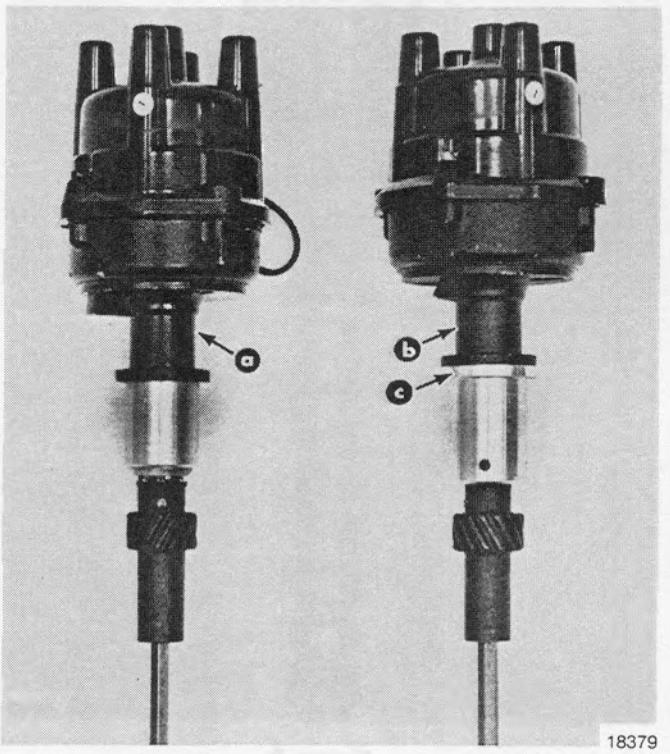


Figure 1
Delco Distributor
MCM 120/140/165



a - MCM/MIE 470 L.H. Rotation
b - MIE 470 R.H. Rotation
c - Spacer on R.H. Rotation Distributor Housing

Figure 2
Delco Distributor
MCM/MIE 470 and MCM 485/488R

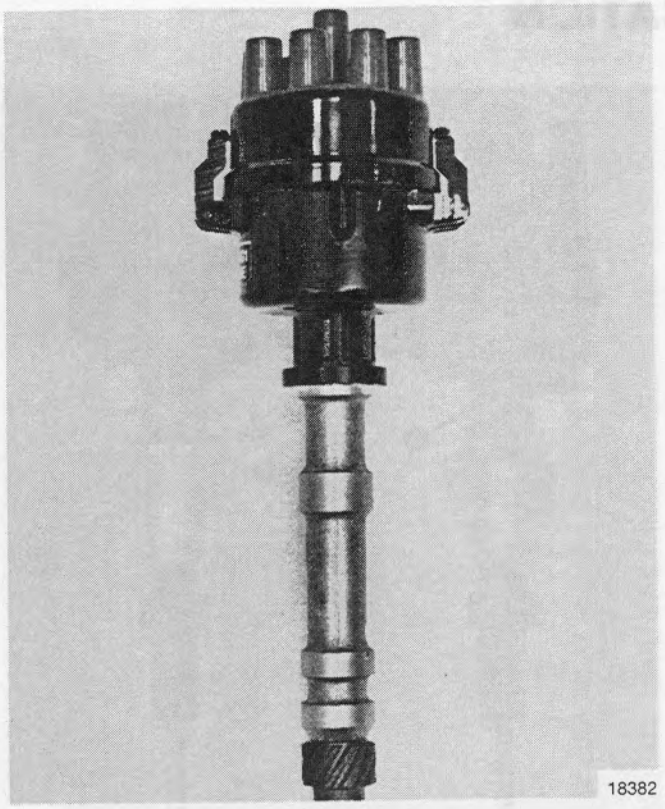


Figure 3

Mallory Distributor
MCM 898/228/260/330/370/400/400 Cyclone/
440 Cyclone/460 Cyclone/475 Turbo and
MIE 228/255/330

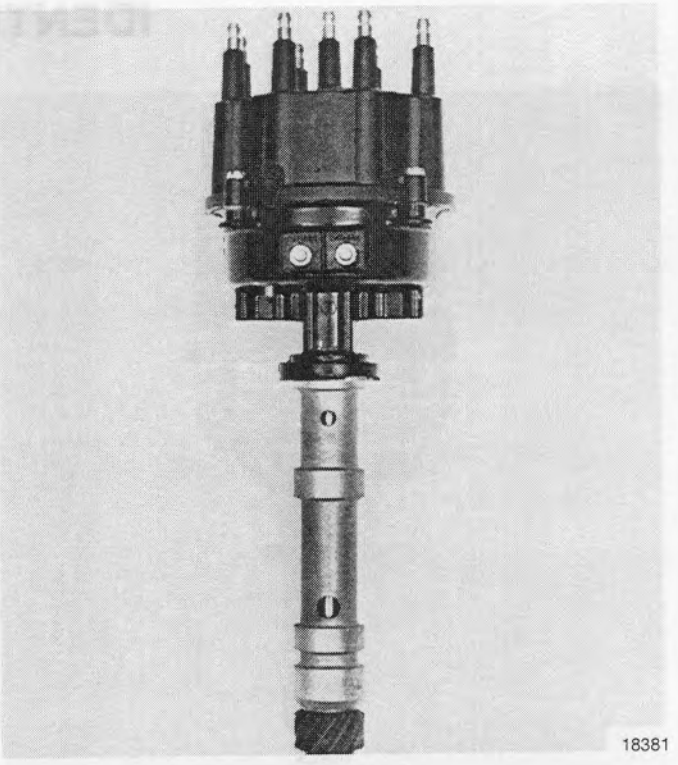


Figure 4

Mercury Marine Thunderbolt IV (HEI) Distributor
MCM 898R/228R/260R/330 (B.W.) and
MIE 230/260/340

REPLACEMENT PARTS WARNING

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

DELCO DISTRIBUTOR SYSTEM
TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m.)
Distributor Clamp 5/16-18	15 (20)
Distributor Clamp 3/8-16	20 (27)
Spark Plugs 14mm	15 (20)

TOOLS/LUBRICANTS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-59339	Dwell Meter
91-76032	Magneto Analyzer
91-52024A1	Remote Starter Switch
91-99379	Timing Light
91-99750	Volt/Ohm Meter

TOOLS OBTAINED LOCALLY
Point Spring Tension Gauge

SEALANTS	
92-25711	Quicksilver Liquid Neoprene

LUBRICANTS OBTAINED LOCALLY
Distributor Cam Lubricant

SPECIFICATIONS

UNIT OF MEASUREMENT
in. (mm)

COIL

Coil Part No.	26433	32193
Max. Operating Amps*	.9	1.1
Primary Resistance*	.9 - 1.2 Ohms	1.3 - 1.5 Ohms
Secondary Resistance*	7,500 - 10,500 Ohms	9,400 - 11,700 Ohms
Secondary Continuity*	53-63	67-77
Resistor Wire	1.8 - 2 Ohms	

*Note: * Use Magneto Analyzer*

DISTRIBUTOR

Model	120	140	165	470	485	488
Condenser*	.18 - .25 MFD.					
Point Dwell	28° - 34°					
Point Gap	.022 (.5)		.016 - .019 (.4 - .45)	.022 (.5)		
Point Spring Tension	19-23 oz. (540 - 650g)					
Timing	8° BTDC	6° BTDC		8° BTDC		

*Note: * Use Magneto Analyzer*

SPARK PLUGS

Model	120	140	165	470	485	488
Gap	.035 (.9)					
Type	AC MR43T Champion RV8C Autolite 144 NGK BR6FS		AC R42TS Champion RV9YC Autolite 13 NGK BPR6FS			

FIRING ORDER

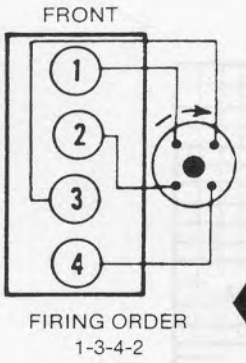


Figure 1

Firing Order

GM 4 Cyl In-Line, MCM 470/485/488 and MIE 470 L.H. and 470 R.H. Rotation Engines

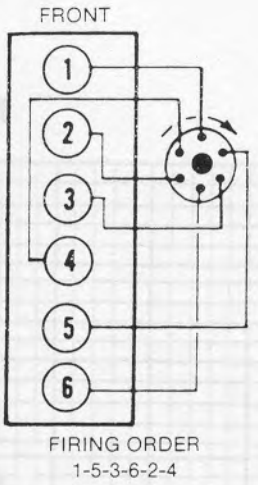


Figure 2

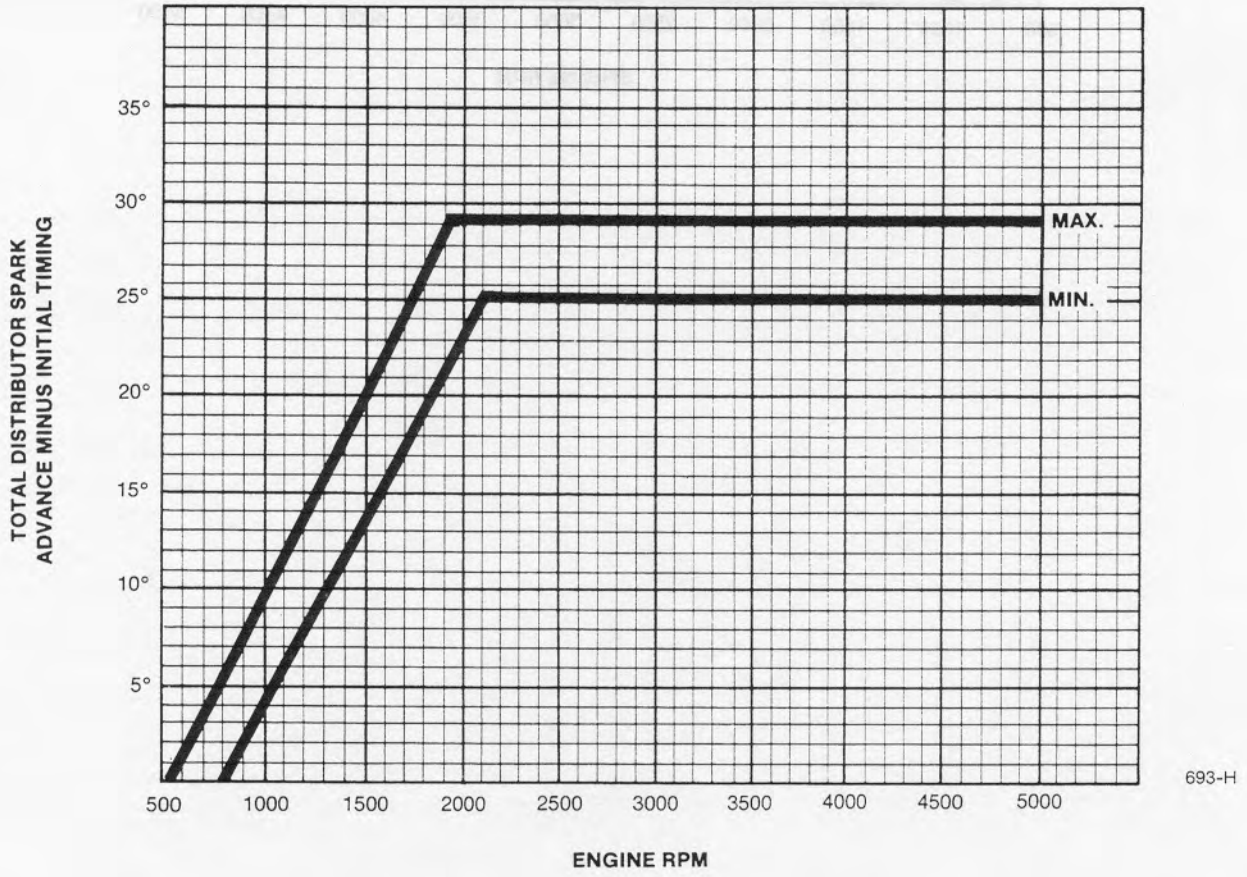
Firing Order for GM 6 Cyl In-Line Engine

DISTRIBUTOR ADVANCE CURVE

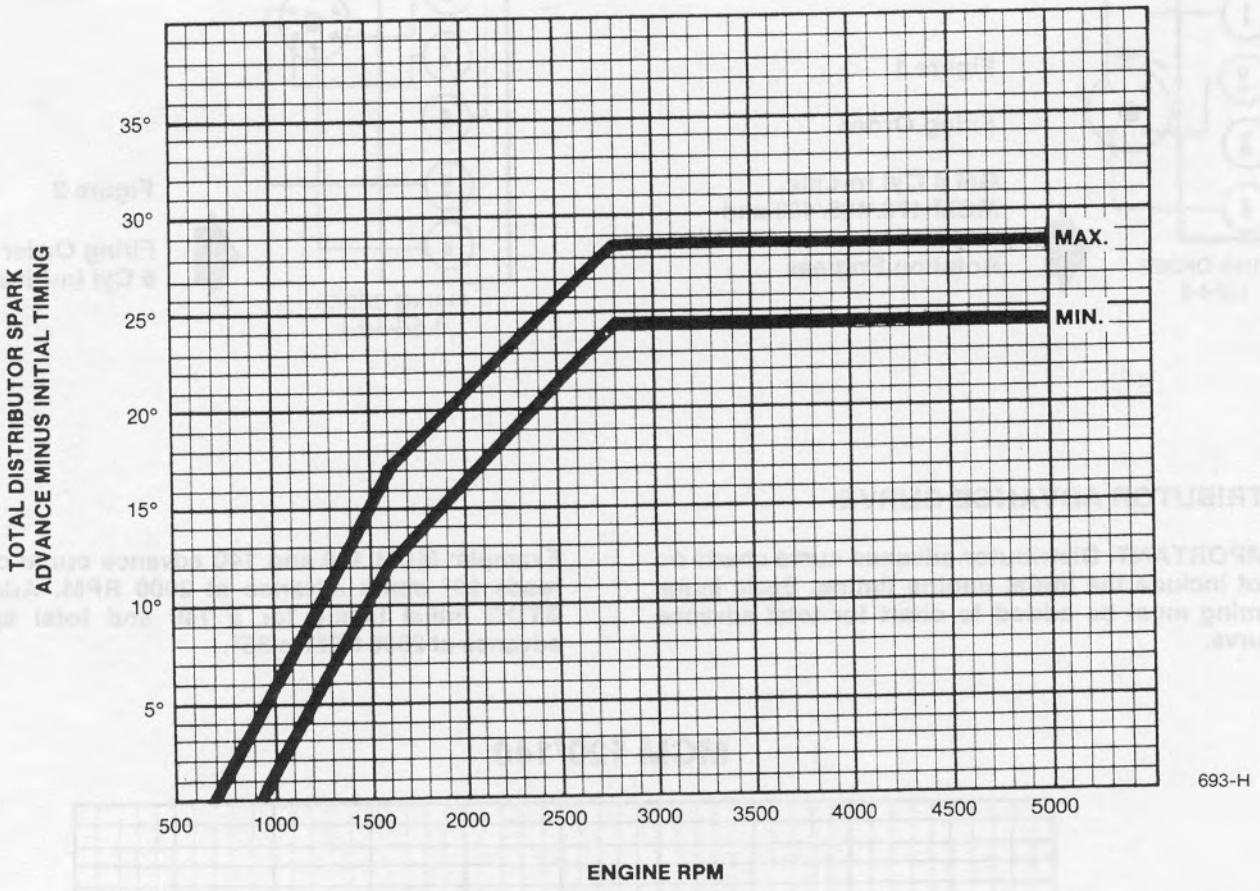
IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.

Example: MCM 120 and 140 advance curve chart reads 29° spark advance at 2000 RPM. Add 6° BTDC initial timing for a 140 and total spark advance at 2000 RPM is 35°.

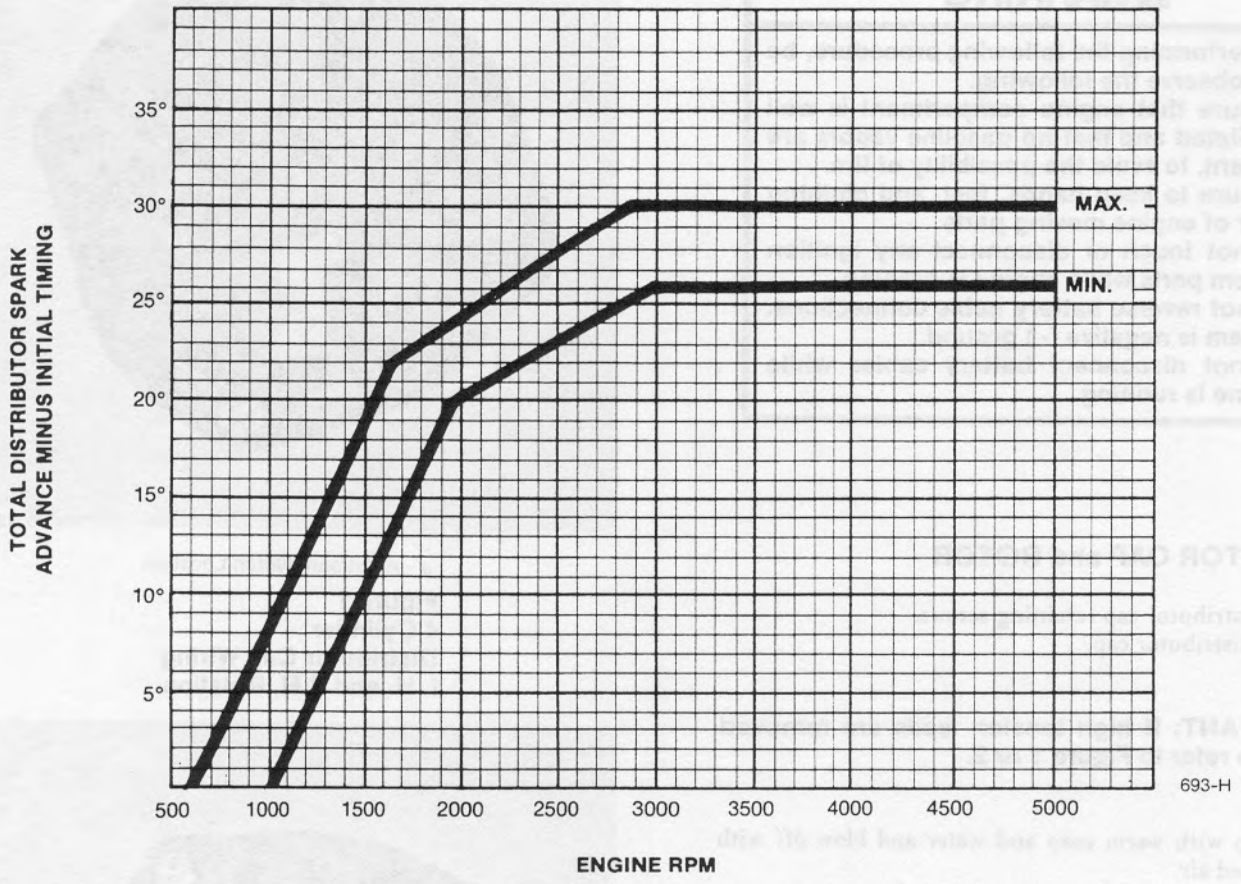
MCM 120/140



MCM 165


TOTAL DISTRIBUTOR SPARK ADVANCE MINUS INITIAL TIMING
35°
30°
25°
20°
15°
10°
5°
MAX.
MIN.
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
ENGINE RPM
693-H

MCM/MIE 470, MCM 485/488



REPAIR

PRECAUTIONS

⚠WARNING

When performing the following procedure, be sure to observe the following.

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet, and clothing clear of engine moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (-) ground.**
- **Do not disconnect battery cables while engine is running.**

DISTRIBUTOR CAP and ROTOR

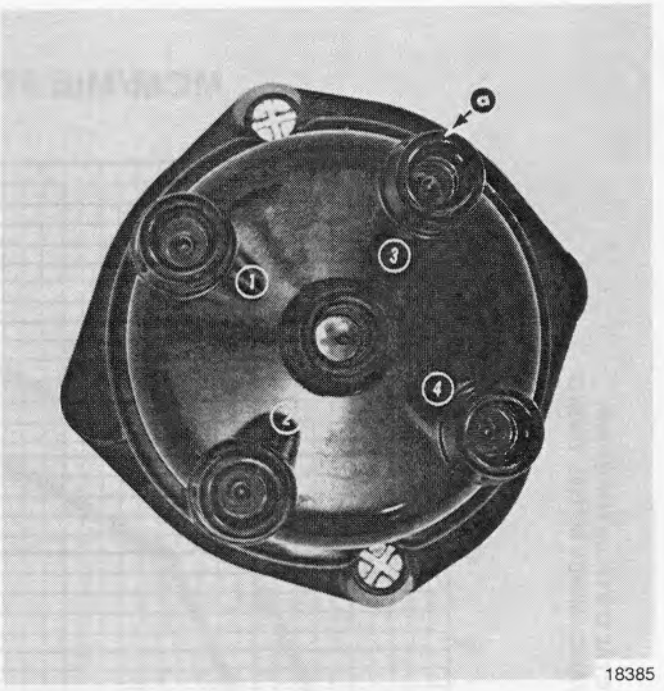
1. Loosen distributor cap retaining screws.
2. Remove distributor cap.

IMPORTANT: If high tension leads are removed from cap refer to Figure 1 or 2.

3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contacts for excessive burning or corrosion. Check center contact for deterioration.

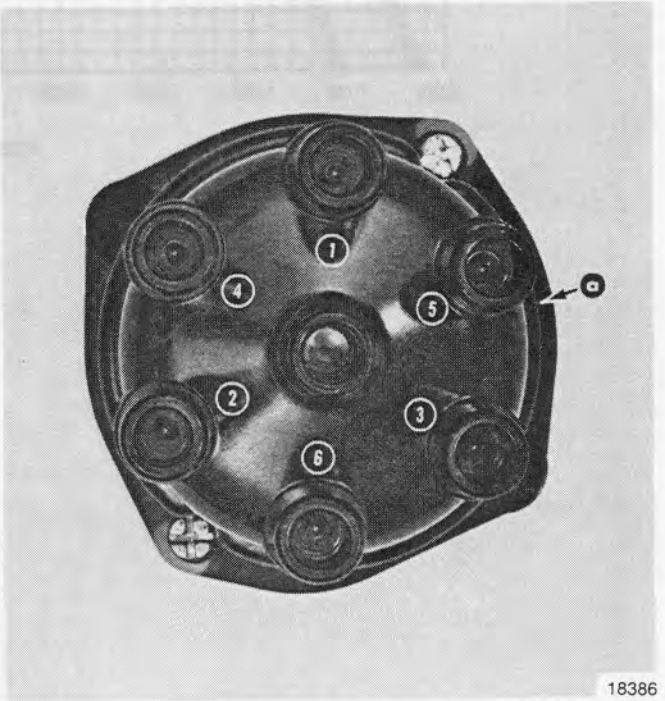
IMPORTANT: Distributor caps (for marine use) should have brass contacts, aluminum contacts should not be used.

5. Check cap for cracks or carbon tracks using Magneto Analyzer.
6. Remove rotor.
7. Check for burned or corroded center contact.
8. Check rotor for cracks and carbon tracks using Magneto Analyzer.
9. Install rotor on shaft. Make sure to line up rotor with keyway on distributor shaft. Be sure rotor is completely seated on distributor shaft.
10. Place cap on distributor. Make sure notch on cap lines up with notch in distributor and cap is firmly seated.
11. Tighten retaining screws securely.
12. Install spark plug wires (if removed) as shown in Figure 1 or 2.



a - Alignment Notch Location

Figure 1
4 Cylinder
Distributor Cap Wiring
L.H. and R.H. Rotation



a - Alignment Notch Location

Figure 2
6 Cylinder
Distributor Cap Wiring

CONTACT POINTS

1. Examine contact points for dirt, wear, pitting and misalignment. Dirty points should be cleaned. Normal point condition is an overall grey color on contact surface.

2. Check for point resistance. A voltage drop of less than .125 volts across points should exist. Make this check with a sensitive volt meter or point resistance meter.

Abnormal Point Wear

1. Points, which have been operated for a period of time, have a rough surface, but this may not mean that points are worn out.

2. If points burn or pit, however, they soon become unsatisfactory for further operation. Not only must they be replaced, but ignition system and engine must be checked to determine cause and elimination of trouble. Unless condition is corrected, new points will provide no better service than old points.

Cleaning of Points

1. Dirty contact points should be dressed with a few strokes of a clean, fine-cut contact file. File should not be used on other metals and should not be allowed to become greasy or dirty.

   IMPORTANT: Never use emery cloth to clean contact points.

2. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily. Do not attempt to remove all roughness nor dress point surfaces down smooth. Merely remove scale or dirt.
3. Badly burned or pitted contact points should be replaced and cause of trouble determined and corrected.

Burning of Points

1. Contact point burning results from high voltage, presence of oil or other foreign material, defective condenser or improper point adjustment.
2. High voltage causes excessively high current flow thru contact points which burns them rapidly. High voltage can result from improperly adjusted or inoperative voltage regulator.
3. Oil or crankcase vapors, which work up into distributor and deposit on point surfaces, cause them to burn rapidly.
4. If contact point opening is too small (cam angle too large), points will be closed too long. Average current flow thru points will be too high, so points will burn rapidly and arcing will occur between points.
5. High series resistance in condenser circuit will prevent normal condenser action, so contact points will burn rapidly. This resistance may be caused by a loose condenser mounting or lead connection, or by poor connections inside condenser.

Pitting of Points

1. Contact point pitting results from an out-of-balance condition in ignition system which causes transfer of material from one point to other so that a tip builds up on one point while a pit forms in other. (Figure 3)

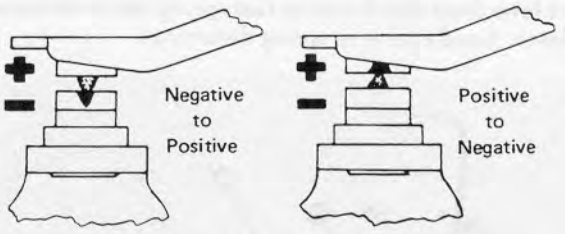


Figure 3. Material Transfer

2. If points are pitted, condenser should be checked for proper capacity.

Replacement

1. Remove primary and condenser lead wires from contact point terminal.
2. Remove contact set attaching screw and lift contact point set from breaker plate.
3. Clean oil smudge and dirt from breaker plate.

   IMPORTANT: Carefully wipe protective film from point set prior to installation.

4. Place a small amount of Distributor Cam Lubricant on distributor cam.
5. Place new contact point assembly in position on breaker plate and install attaching screw.
6. Check points for porper alignment. If points do not align properly, replace with another set of points. (Figure 4)

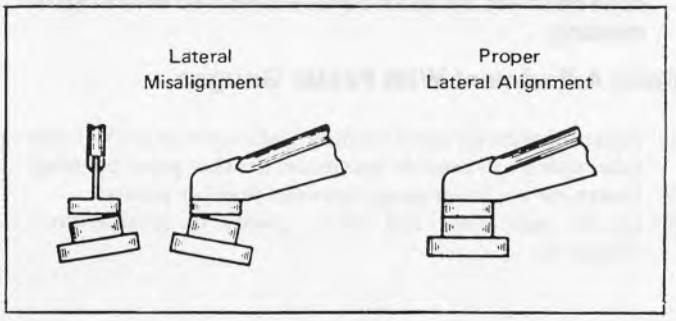
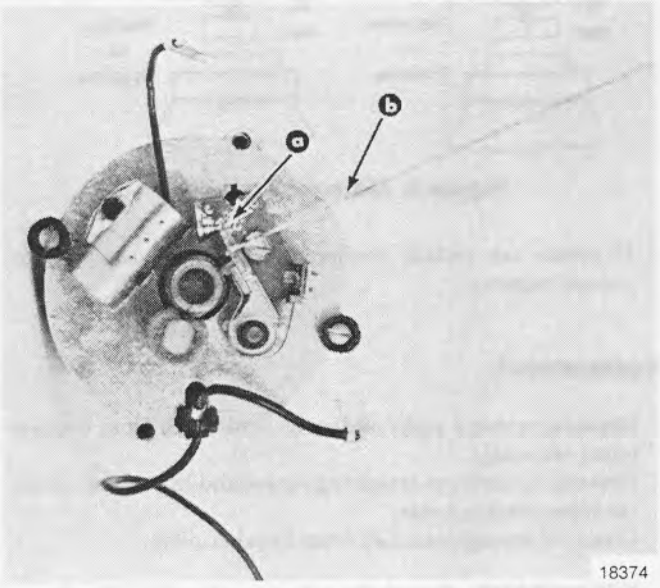


Figure 4

7. Connect primary and condenser lead wires to terminal on contact point set.
8. Check point spring tension (Figure 5).

Contact point spring tension must fall within specified limits. Weak tension will cause chatter which results in arcing and burning of points and an ignition miss at high speed, while excessive tension will cause undue wear of contact points, cam and rubbing block. Contact point tension should be checked with a spring gauge. Scale should be hooked to breaker lever and pull exerted at 90° to breaker lever. Reading should be taken just as points separate. Tension can be adjusted by bending breaker lever spring. If tension is excessive, it can be decreased by pinching spring carefully. To increase tension, remove lever from distributor so that spring can be bent away from lever. Avoid excessive spring distortion.



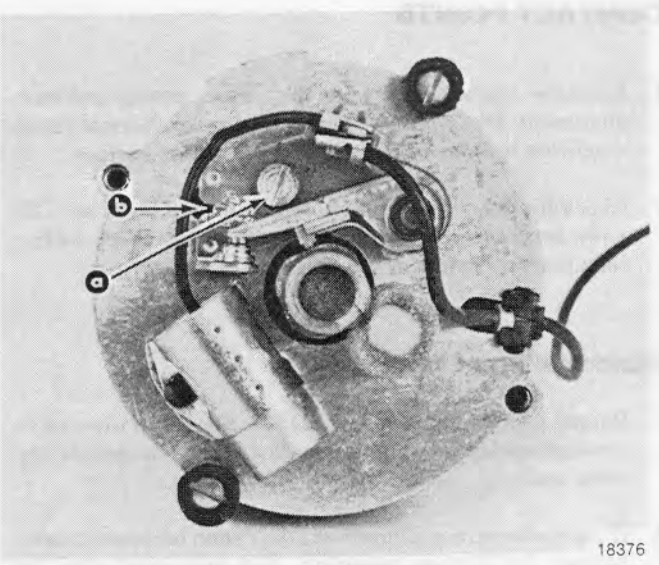
a - Movable Contact
b - Spring Tension Gauge

Figure 5

IMPORTANT: Point gap or (dwell) can be adjusted by 2 methods. It is preferred that points be adjusted with a feeler gauge, then checked with a dwell meter. Points, however, also can be adjusted, as well as checked, with a dwell meter: After points have been set, dwell should be checked with engine running.

Point Adjustment With Feeler Gauges

1. Rotate distributor until rubbing block rests on peak of cam lobe, which will provide maximum breaker point opening.
2. Insert correct feeler gauge between breaker points.
3. Loosen lock screw and adjust points to specifications (Figure 6).



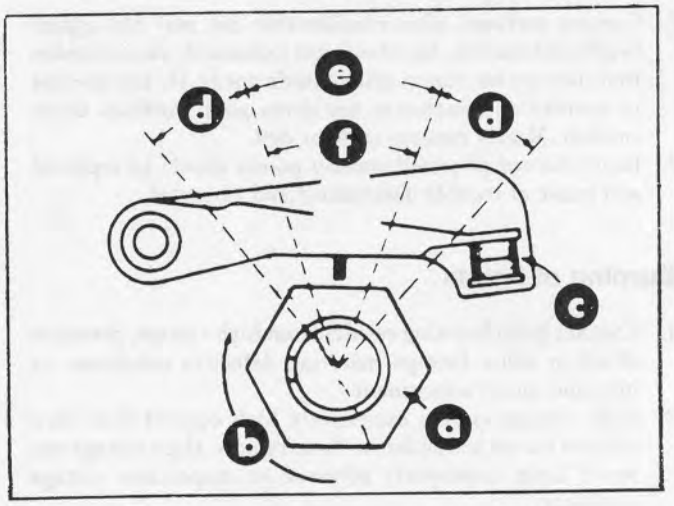
a - Lock Screw b - Adjustment Slot

Figure 6

Dwell Adjustment

1. Remove distributor cap and rotor.
2. Connect positive (+) dwell meter lead to negative (-) side of coil. Connect negative (-) meter lead to ground.
3. Loosen point lock screw slightly.
4. While cranking engine with starter, adjust dwell with a screwdriver (Figure 6) to obtain reading on dwell meter, as specified in "Specifications", and tighten lock screw. (Dwell reading will be unsteady using this method.)

IMPORTANT: Cam angle increases as point opening is decreased and vice versa. (Figure 7)



a - Cam
b - Direction of Rotation
c - Breaker Points
d - Points Open
e - Points Close
f - Cam Angle or Dwell

Figure 7. Cam Angle

5. Install rotor and distributor cap and recheck dwell with engine running.

IMPORTANT: Dwell should be checked between idle and 1750 RPM. Any dwell reading variations of more than 3° between idle and 1750 RPM would indicate wear in the distributor. Cam angle readings, taken at speeds above 1750 engine RPM, may prove unreliable on some dwell meters.

CONDENSER

1. Use Magneto Analyzer for test.
2. Test condenser for the following:
   a. Condenser capacity test.
   b. Condenser leakage and short test.
   c. Condenser series resistance test.
3. Replace condenser if test results are not within specifications.

COIL

1. Use Magneto Analyzer for test.
2. Check coil for the following:
   a. Coil power test.
   b. Coil surface insulation test.
   c. Coil continuity test.
   d. Primary resistance test.
   e. Secondary resistance.
3. Replace coil if test results are not within specifications.

IGNITION RESISTANCE WIRE

Engine with Electric Choke

1. Disconnect wire from positive (+) side of coil.
2. Unplug quick disconnect (with 2 wires) from electric choke heater element.
3. Connect ohmmeter leads to ends of disconnected wires. Replace resistor wire if reading is not within specifications.
4. Reconnect wires to coil and choke.
5. For instructions on replacing resistor wire refer to "Section 3, Part E".

Engine without Electric Choke

1. Disconnect wire from positive (+) side of coil.
2. Unplug instrumentation harness from engine harness.
3. Connect one ohmmeter lead to wire removed from coil. Connect other ohmmeter lead to No. 5 pin hole in engine harness. (Figure 8) Replace resistor wire if reading is not within specifications.
4. Reconnect wire to coil. Plug instrumentation harness onto engine harness and tighten retaining clamp securely.
5. For instructions on replacing resistor wire refer to "Section 3, Part E".

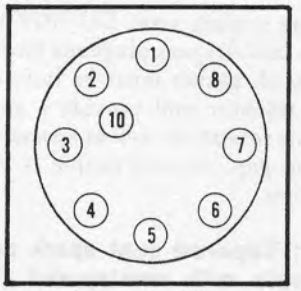


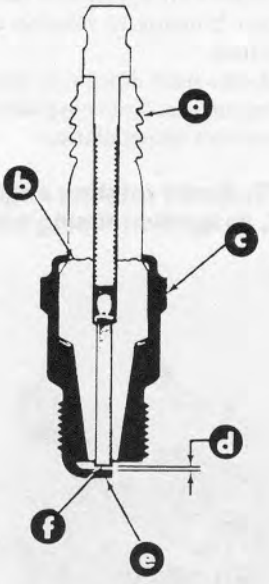
Figure 8. Engine Harness Connector

SPARK PLUGS

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number or heat range. Refer to "Specifications" for spark plug numbers.

IMPORTANT: Never bend the center electrode to adjust gap. Always adjust by bending ground or side electrode.

3. Adjust spark plug gaps with a round feeler gauge. (Figure 9) Refer to "Specifications" for proper spark plug gap.



a - Porcelain Insulator
b - Insulator Cracks Often Occur at this Point
c - Shell
d - Proper Gap
e - Side Electrode (Bend to Adjust Gap)
f - Center Electrode (File Flat When Adjusting Gap - Do Not Bend)

Figure 9. Spark Plug Detail

4. Clean spark plug seating area. DO NOT use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas-tight seal in cylinder. For this reason, as well as necessity of maintaining correct plug gap, correct torque is very important during installation.

IMPORTANT: Tapered seat spark plugs are not inter-changeable with nontapered (with gasket) spark plugs.

HIGH TENSION LEADS

1. Inspect high tension leads for damage.
2. Check high tension leads for continuity.
3. Replace any leads that are cracked, cut, or have damaged spark plug boots.
4. Replace any leads that do not show continuity from end to end.
5. Reinstall high tension leads in proper order.

IMPORTANT: Proper positioning in high tension lead supports is important to prevent cross firing.

DISTRIBUTOR REPAIR (G.M. In-Line Engines)

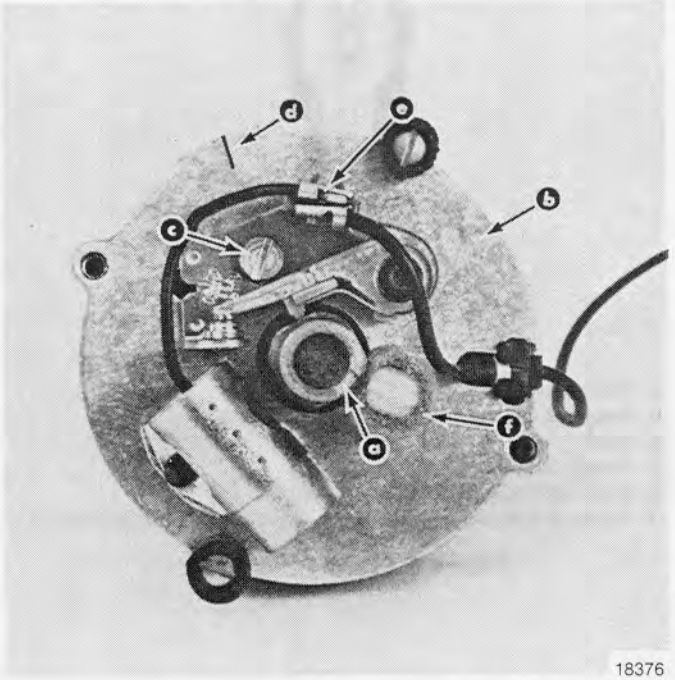
REMOVAL

1. Disconnect distributor primary lead from coil terminal.
2. Remove distributor cap and rotor.

IMPORTANT: If necessary to remove leads from distributor cap, mark position on cap tower for lead to No. 1 cylinder. This will aid in reinstallation of leads in cap.

3. Scratch a realignment mark on distributor in line with rotor notch (located on distributor shaft). (Figure 1)
4. Mark distributor housing in relation to engine block for ease in installation.
5. Remove distributor hold-down bolt and clamp and remove distributor from engine. Note position of assembly relative to engine for correct reinstallation.

IMPORTANT: Avoid rotating engine with distributor removed, as ignition timing will be upset.



18376

a - Rotor Alignment Notch
b - Breaker Plate
c - Breaker Point Attaching Screw
d - Alignment Mark
e - Quick Disconnect Terminal
f - Lubrication Wick

Figure 1. Breaker Plate and Attaching Parts

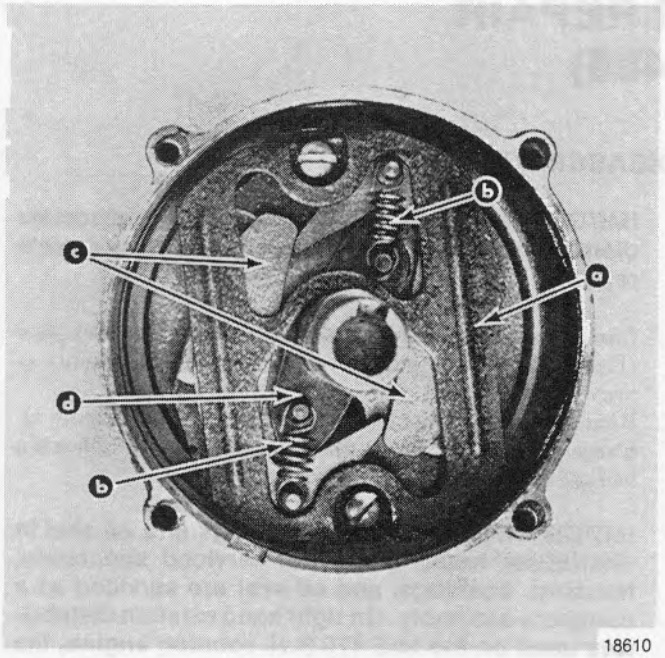
DISASSEMBLY

IMPORTANT: It is not necessary to disassemble distributor any further than required to complete repairs.

1. Remove condenser and breaker points from breaker plate. (Figure 1) Test condenser and check breaker points.
2. Remove breaker plate from distributor housing. (Figure 1) Excessive oil on breaker plate assembly would indicate a bad oil seal in distributor housing.

IMPORTANT: Main shaft bushings and oil seal in housing are not serviced separately. Housing, bushings and oil seal are serviced as complete assembly.

3. Remove roll pin retaining driven gear to main shaft and slide gear from shaft.
4. Check for side plate between main shaft and bushings in distributor housing. Maximum side play allowed is .002" (.05mm).
5. Remove main shaft from housing and inspect for worn cam lobes. Check shaft for being bent by placing in v-blocks and checking run out with a dial indicator. Maximum run out allowed is .002" (.05mm).
6. Remove weight cover, check weights and weight stop for wear. Check weights for free movement on pins. (Figure 2)

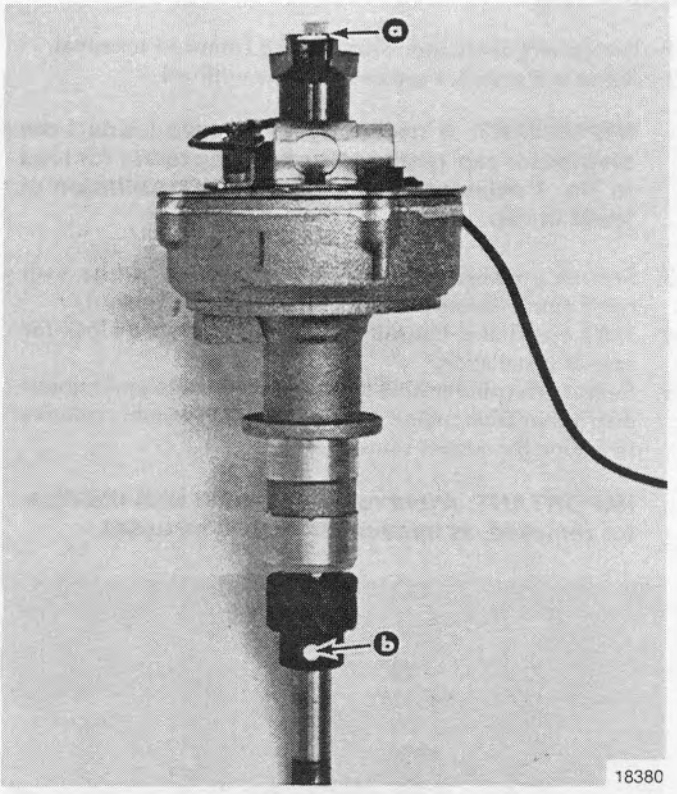


a - Weight Cover
b - Weight Springs
c - Weights
d - Weight Stop

Figure 2. Advance Weights and Components

REASSEMBLY

1. Install weights and springs on pivot pins. (Figure 2)
2. Install weight cover. (Figure 2)
3. Lubricate main shaft with engine oil and install in distributor housing.
4. Install thrust washers (if applicable) and install driven gear on main shaft.
5. Line up mark on driven gear with rotor notch on main shaft. (Figure 3)
6. Install roll pin through gear and main shaft.
7. Install breaker plate on distributor housing. (Figure 1)
8. Install condenser and breaker points on breaker plate. (Figure 1)
9. Install distributor as outlined in "Distributor Installation", (see Index).



a - Rotor Contact
b - Gear Alignment Mark

Figure 3. Gear Installation

DISTRIBUTOR REPAIR (470-485-488)

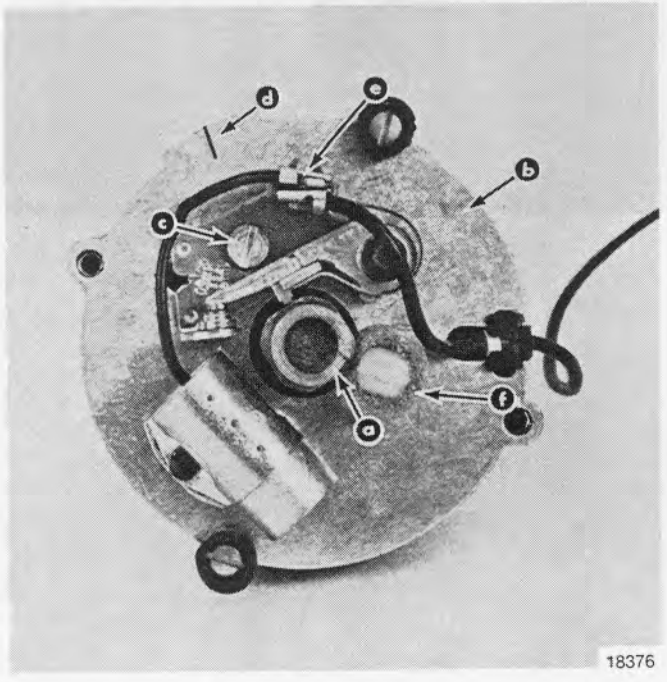
REMOVAL

1. Disconnect distributor primary lead from coil terminal.
2. Remove distributor cap and rotor as outlined.

IMPORTANT: If necessary to remove leads from distributor cap, mark position on cap tower for lead to No. 1 cylinder. This will aid in reinstallation of leads in cap.

3. Scratch a realignment mark on distributor in line with rotor notch (located on distributor shaft). (Figure 1)
4. Mark distributor housing in relation to engine block for ease of installation.
5. Remove distributor hold-down bolt and clamp and remove distributor from engine. Note position of assembly relative to engine for correct reinstallation.

IMPORTANT: Avoid rotating engine with distributor removed, as ignition timing will be upset.



a - Rotor Alignment Notch
b - Breaker Plate
c - Breaker Point Attaching Screw
d - Alignment Mark
e - Quick Disconnect Terminal
f - Lubrication Wick

Figure 1. Breaker Plate and Attaching Parts

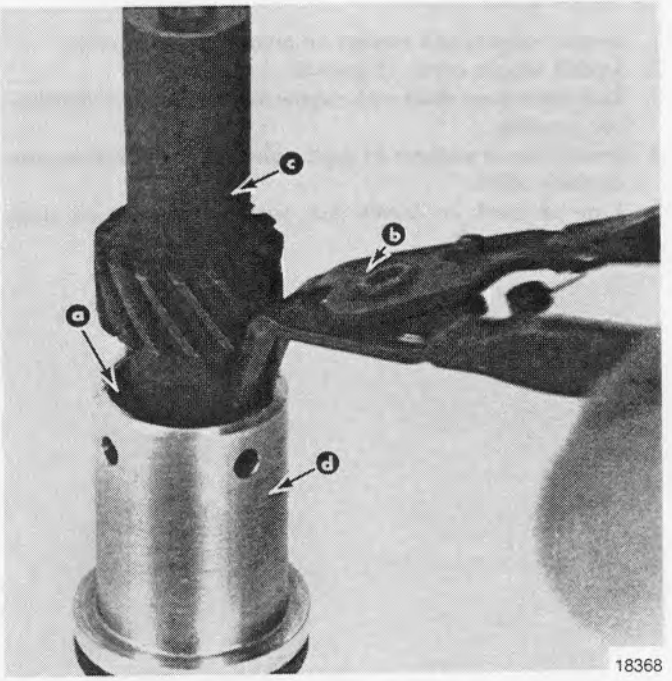
DISASSEMBLY

IMPORTANT: It is not necessary to disassemble distributor any further than required to complete repairs.

1. Remove condenser and breaker points from breaker plate (Figure 1). Test condenser and check breaker points as previously outlined.
2. Remove breaker plate from distributor housing (Figure 1). Excessive oil on breaker plate assembly would indicate a bad oil seal in distributor housing.

IMPORTANT: Main shaft bushings and oil seal in distributor housing are not serviced separately, housing, bushings, and oil seal are serviced as a complete assembly. On right hand rotation distributors used on the MIE 470 R.H. rotation engine, the distributor housing is not available separately. You must purchase a new distributor assembly.

3. Remove roll pin retaining driven gear to main shaft (on R.H. rotation distributor you must also remove lock ring as shown in Figure 2) and slide driven gear and driven shaft from main shaft. Remove thrust washers from main shaft.



a - Lock Ring
b - Bent Lock Ring Pliers
c - R.H. Rotation Gear
d - R.H. Rotation Distributor Housing

Figure 2. R.H. Rotation Only Gear Removal

4. Slide driven gear from driven shaft, being careful not to lose spring on top of driven shaft.
5. Check for side play between main shaft and bushings in distributor housing, maximum side play allowed is .002" (.05mm).
6. Remove main shaft from housing and inspect for worn cam lobes, check shaft for being bent by placing in V-blocks and checking run out with a dial indicator. Maximum run out allowed is .002" (.05mm).
7. Remove weight cover, check weights and weight stop for wear. Check weights for free movement on pins. (Figure 3)

18610

a - Weight Cover
b - Weight Springs
c - Weights
d - Weight Stop

Figure 3

REASSEMBLY

1. Install weights and springs on pivot pins (Figure 2).
2. Install weight cover (Figure 3).
3. Lubricate main shaft with engine oil and install in distributor housing.
4. Install spring on drive shaft and install drive gear onto driven shaft.
5. Install thrust washers onto main shaft.
6. Install drive gear onto main shaft using one of the following 3 methods.

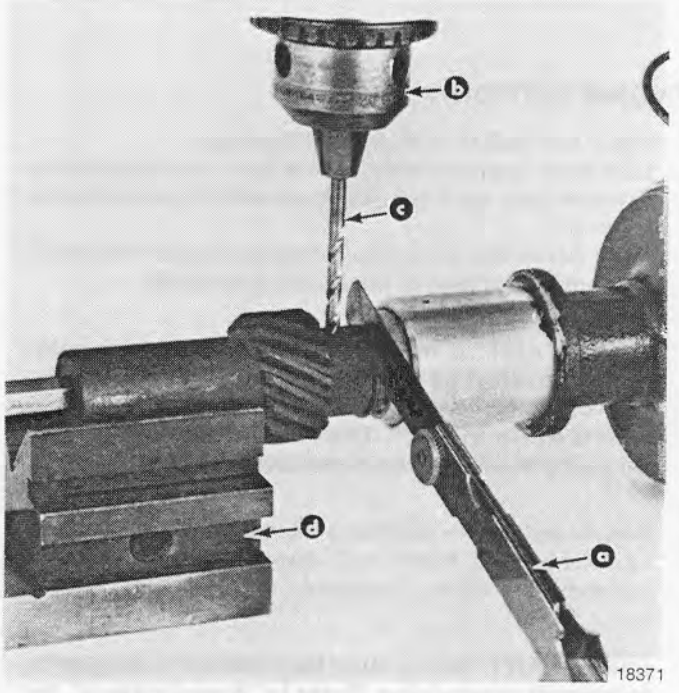
   Used Gear: Line up holes in gear with hole in main shaft and install roll pin through gear and main shaft. (Also install lock ring on R.H. rotation distributor).

New Gear L.H. Rotation Distributor:
Hold a light downward pressure on distributor shaft. Install distributor gear onto distributor shaft. Insert a .030" feeler gauge between distributor housing washers and distributor gear. Position distributor shaft and new gear so you will drill the new hole 90° from the old hole in the distributor shaft. Place shaft and new gear on V-blocks and drill through gear and shaft. Install roll pin through gear and main shaft. (Figure 4)

IMPORTANT: The hole should be drilled with a 5/32" carbide tipped drill. In most cases it is recommended to have a machine shop complete this operation.

New Gear R.H. Rotation Distributor:
Install distributor gear onto distributor shaft. Install lock ring in distributor housing. (Figure 2) Position distributor shaft and new gear so you will drill the new hole 90° from the old hole in the distributor shaft. Place shaft and new gear on V-blocks and drill through gear and shaft (Figure 4). Install roll pin through gear and main shaft.

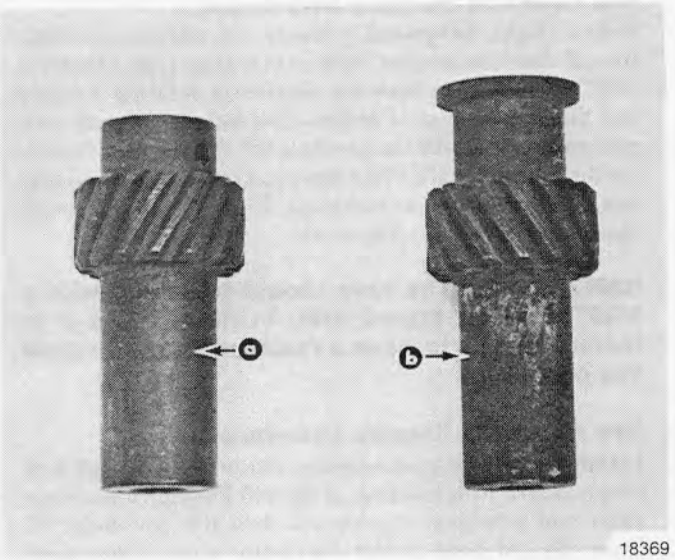
IMPORTANT: the hole should be drilled with a 5/32" carbide tipped drill. In most cases it is recommended to have a machine shop complete this operation.



18371

a - .030" (.75mm) Feeler Gauge - L.H. Rotation Engines Only
b - Drill Press
c - 5/32" Carbide Tipped Drill
d - V-Block

Figure 4. Drilling Gear and Shaft



a - MCM 470-485-488-MIE 470 L.H. Rotation Distributor Gear
b - MIE 470 R.H. Rotation Gear

Figure 5

7. Install breaker plate on distributor housing. (Figure 1)
8. Install condenser and breaker points on breaker plate. (Figure 1)
9. Install distributor as outlined in "Distributor Installation" (see Index).

DISTRIBUTOR INSTALLATION

IMPORTANT: On 470, 485, and 488 models oil pump alignment should be checked, refer to Section 6, Part B for correct procedure.

ENGINE NOT DISTURBED

1. Install new gasket on distributor housing.
2. Turn rotor approximately ⅛-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor postioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil. Also install spark plug and coil secondary wires, if removed.

IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Refer to "Specification", for firing order.

5. Set point gap and dwell.
6. Install rotor and cap.
7. Time ignition as outlined under "Ignition Timing".

ENGINE DISTURBED

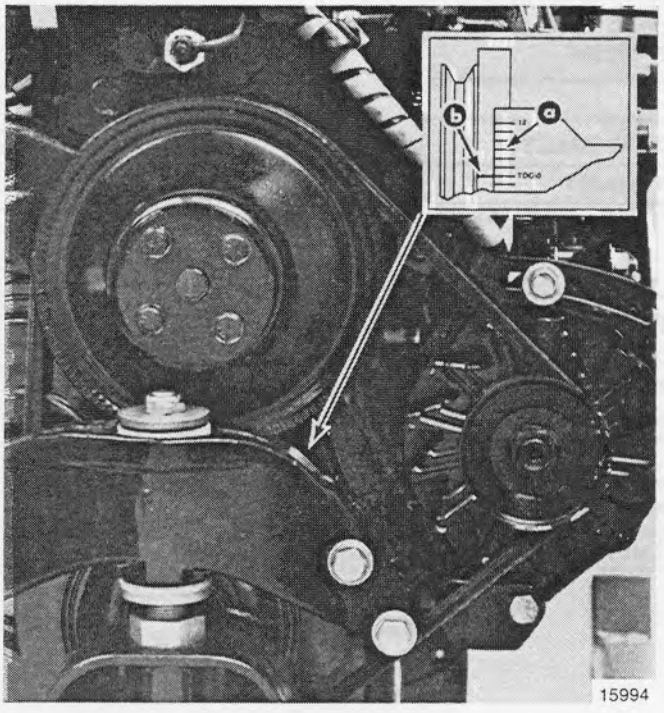
1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley or . . .
   b. Remove rocker cover and crank engine until No.1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately ⅛-turn more toward left and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install cap, distributor primary lead to coil. Check all high tension wire connections and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Refer to Specifications for firing order.
8. Set point gap and dwell.
9. Time ignition as outlined under "Ignition Timing".

IGNITION TIMING

IMPORTANT: Dwell must be set to specification before adjusting timing.

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to battery (12 volts). Refer to "Specifications" for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing marks as shown in Figures 1 or 2.
5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up with mark on tab specified in "Specifications". Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

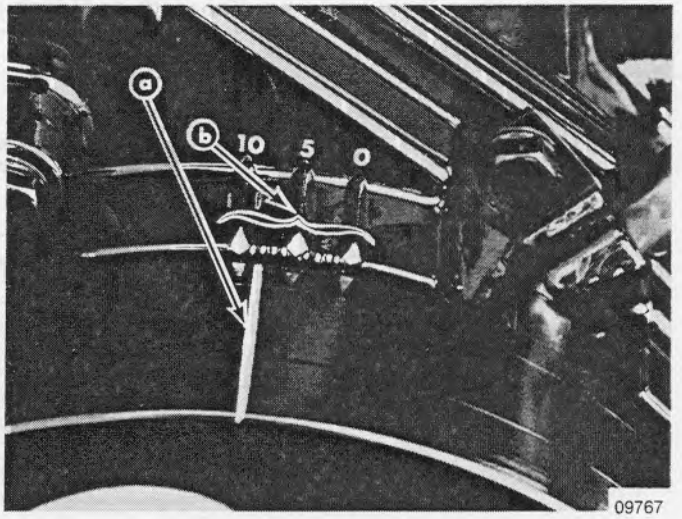
IMPORTANT: GM engine timing marks (on tab) are in 2° increments. Timing must be set on the "A" (Advance) side of "O" (Top Dead Center)



a - Timing Mark
b - Degree Marks

Figure 1. Timing Marks on GM 4 and 6-Cylinder Engines

IMPORTANT: 470-485-488 timing marks (on tab) are in 1° increments. MCM and MIE L.H. engines will have the 10° mark to the left of "O". MIE 470 R.H. rotation engines will have the 10° mark to the right of "O"



a - Timing Mark b - Degree Marks

Figure 2. Timing Marks on 470-485-488

MALLORY DISTRIBUTOR SYSTEM
TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Distributor Clamp 3/8-16	20 (27)
Spark Plugs (14mm)	15 (20)

TOOLS/LUBRICANTS/SEALANTS

TOOLS	
91-59339	Dwell Meter
91-76032	Magneto Analyzer
91-52024A1	Remote Starter Switch
91-99379	Timing Light
91-99750	Volt/Ohm Meter

TOOLS OBTAINED LOCALLY
Spring Tension Gauge

SEALANTS	
92-25711	Quicksilver Liquid Neoprene

LUBRICANT OBTAINED LOCALLY
Distributor Cam Lubricant

SPECIFICATIONS

UNIT OF MEASUREMENT
in. (mm)

COIL

Coil Part No.	26433	32193
Max. Operating Amps *	.9	1.1
Primary Resistance *	.9 - 1.2 ohms	1.1 - 1.5 ohms
Secondary Resistance *	7,500 - 10,500 ohms	9,500 - 15,000 ohms
Secondary Continuity *	53-63	60-70
Resistor Wire *	1.8 - 2 ohms	

*Note: * Use Magneto Analyzer*

DISTRIBUTOR

MODEL	MCM 898	MCM/MIE 228	MIE 255 MCM/MIE 260	MCM/MIE 330	MIE 340	MCM 370/400	400 Cyclone	440/460 Cyclone	475 Turbo
Condenser*	.26 - .30 MFD.								
Point Dwell	26° - 31°						28° - 31°		
Point Gap	.016 - .019 (.4 - .45)								
Timing	8° BTDC					10° BTDC		15° BTDC	16° BTDC
Point Spring Tension	25 - 30 oz. (709-850g)								

*Note: * Use Magneto Analyzer*

SPARK PLUGS

MODEL	MCM 898	MCM/MIE 228	MIE 255 MCM/MIE 260	MCM/MIE 330	MIE 340	MCM 370/400 400/440 Cyclone	460 Cyclone	475 Turbo
Plug Gap	.035 (.9)							
Plug Type	AC - MR43T/Champion RV8C Autolite - 144/NGK-BR6FS						AC-MR41T	Champion V-4C

Note 1: Use magneto analyzer

FIRING ORDER

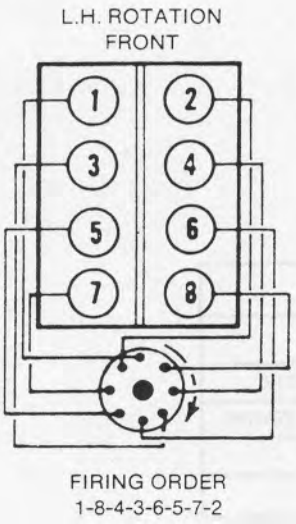


Figure 1. MCM 898/228/260/330/370/ 400/400 Cyclone/440 Cyclone/ 460 Cyclone/475 Turbo/ MIE 228/255/330/L.H. (Standard) Rotation

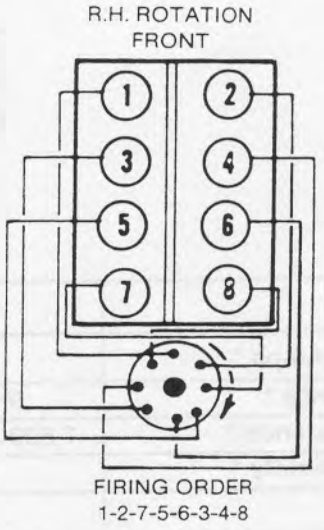


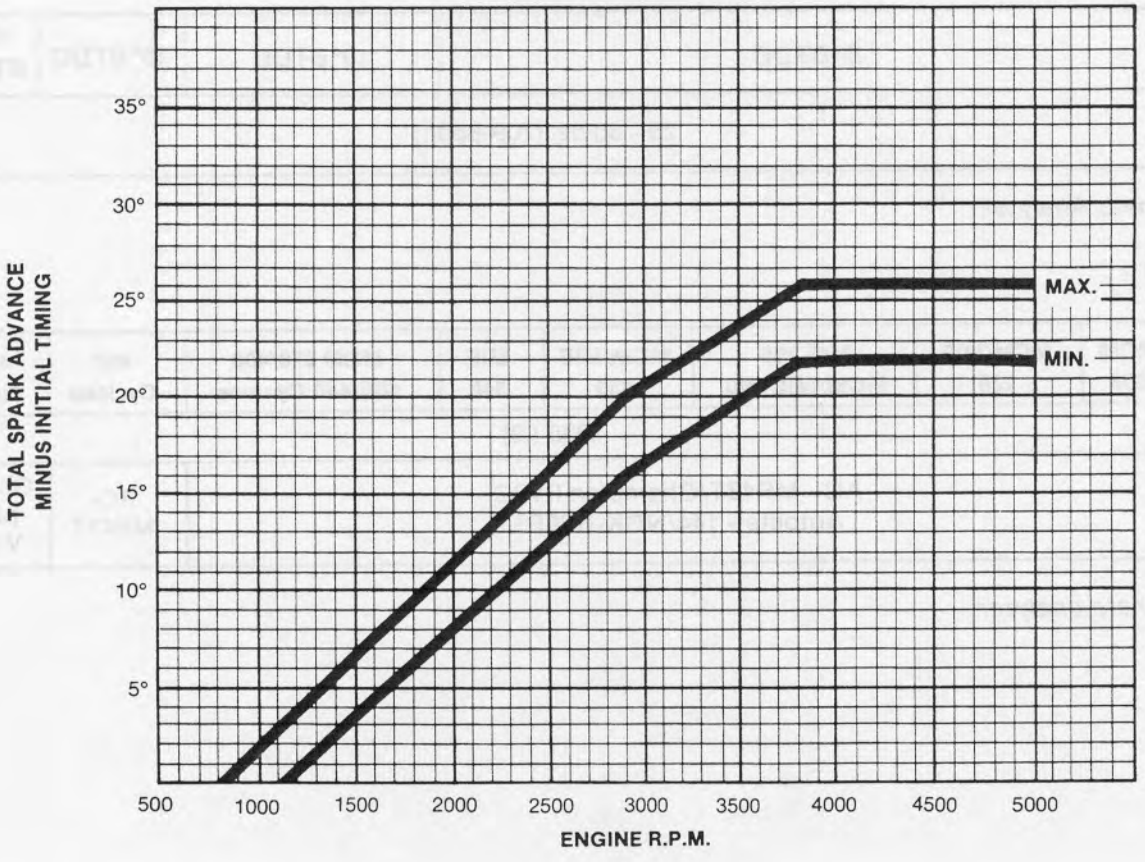
Figure 2. MIE 228/255/330 R.H. (Opposite) Rotation

DISTRIBUTOR ADVANCE CURVE

IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Initial engine timing must be added to chart for total advance curve.

EXAMPLE: A 898 on the following chart reads 20° spark advance at 2900 R.P.M. Add 8° BTDC initial timing for an 898 and total spark advance would be 28° at 2900 R.P.M.

MCM 898/228/260/330
MIE 228/255/330



TOTAL SPARK ADVANCE FOR HIGH PERFORMANCE ENGINES

IMPORTANT: This chart shows total spark advance including the initial timing of the engine.

Model	Max. Spark Advance	Engine R.P.M.
370/400	34°	3500
400 Cyclone	36°	3500
440 Cyclone	36°	3500
460 Cyclone	36°	3500
475 Turbo	28°	3500

REPAIR

PRECAUTIONS

⚠WARNING

When Performing the following procedure, be sure to observe the following.

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibiltiy of fire.**
- **Be sure to keep hands, feet, and clothing clear of engine moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (-) ground.**
- **Do not disconnect battery cables while engine is running.**

DISTRIBUTOR CAP AND ROTOR

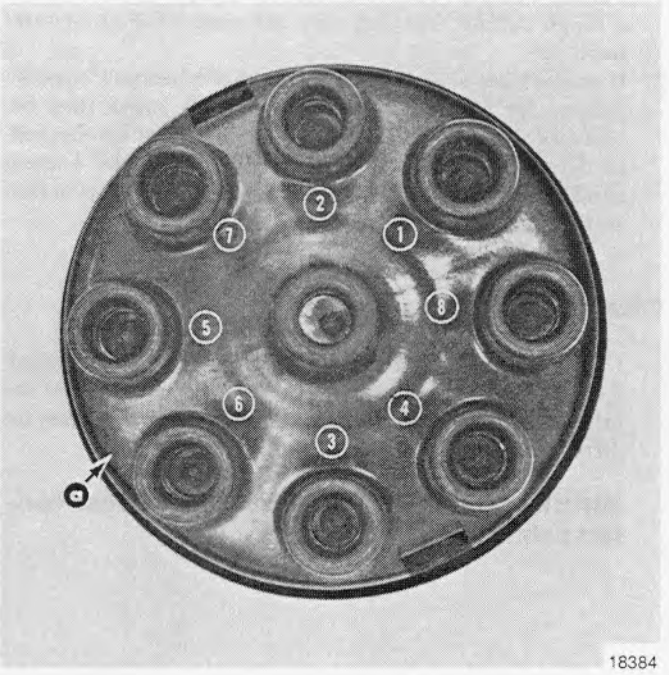
1. Loosen distributor cap clamp retaining screws.
2. Remove distributor cap.

IMPORTANT: If high tension leads are removed from cap refer to Figure 1 or 2.

3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contacts for excessive burning or corrosion. Check center contact for deterioration.

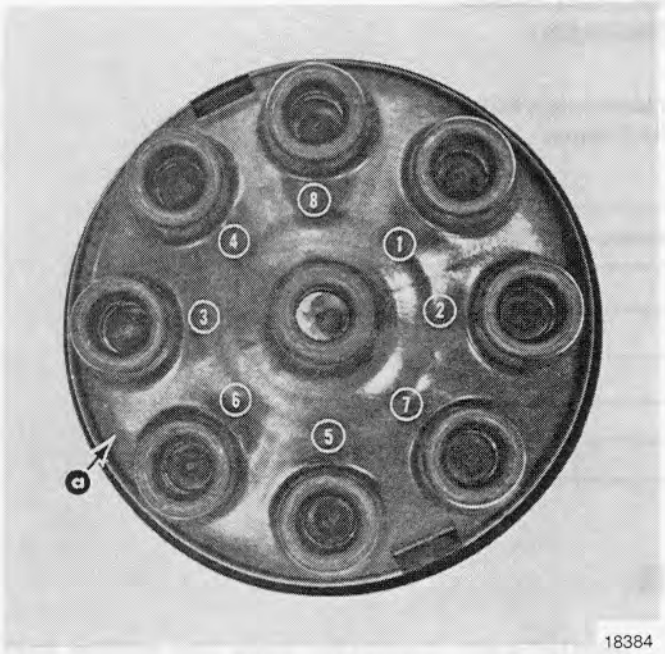
IMPORTANT: Distributor caps (for marine use) should have brass contacts, aluminum contacts should not be used.

5. Check cap for cracks or carbon tracks using Magneto Analyzer.
6. Lift rotor up, off of distributor shaft.
7. Check for burned or corroded center contact.
8. Check rotor for cracks and carbon tracks using Magneto Analyzer.
9. Install rotor on shaft. Make sure to line up rotor with keyway on distributor shaft. Be sure rotor is completely seated on distributor shaft.
10. Place cap on distributor. Make sure notch on cap lines up with notch in distributor and cap is firmly seated.
11. Tighten clamp retaining screws.
12. Install spark plug wires (if removed) as shown in Figure 1 or 2.



a - Alignment Notch

Figure 1. L.H. Rotation



a - Alignment Notch

Figure 2. R.H. Rotation

CONTACT POINTS

1. Examine contact points for dirt, wear, pitting and misalignment. Dirty points should be cleaned. Normal point condition is an overall grey color on contact surface.
2. Check for point resistance. A voltage drop of less than .125 volts across points should exist. Make this check with a sensitive volt meter of point resistance meter.

Abnormal Point Wear

1. Points, which have been operated for a period of time, have a rough surface, but this may not mean that points are worn out.
2. If points burn or pit, however, they soon become unsatisfactory for further operation. Not only must they be replaced, but ignition system and engine must be checked to determine cause and elimination of trouble. Unless condition is corrected, new points will provide no better service than old points.

Cleaning of Points

1. Dirty contact points should be dressed with a few strokes of a clean, fine-cut contact file. File should not be used on other metals and should not be allowed to become greasy or dirty.

IMPORTANT: Never use emery cloth to clean contact points.

2. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily. Do not attempt to remove all roughness nor dress point surfaces down smooth. Merely remove scale or dirt.
3. Badly burned or pitted contact points should be replaced and cause of trouble determined and corrected.

Burning of Points

1. Contact point burning results from high voltage, presence of oil or other foreign material, defective condenser or improper point adjustment.
2. High voltage causes excessively high current flow thru contact points which burns them rapidly. High voltage can result from improperly adjusted or inoperative voltage regulator.
3. Oil or crankcase vapors, which work up into distributor and deposit on point surfaces, cause them to burn rapidly.
4. If contact point opening is too small (cam angle too large), points will be closed too long. Average current flow thru points will be too high, so points will burn rapidly and arcing will occur between points.

Pitting of Points

1. Contact point pitting results from an out-of-balance condition in ignition system which causes transfer of material from one point to other so that a tip builds up on one point while a pit forms in other. (Figure 3)

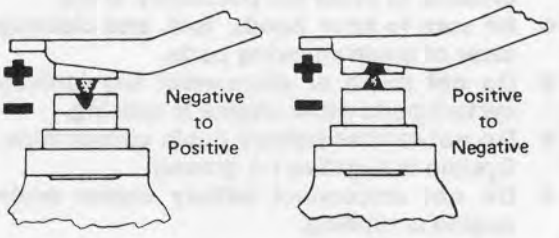


Figure 3. Material Transfer

2. If points are pitted, condenser should be checked for proper capacity.

Replacement

1. Remove primary lead from primary terminal on distributor. Remove primary terminal screw and nut from distributor. (Use care not to lose the 2 insulator bushings in distributor housing). Remove condenser lead and point lead from primary terminal screw.
2. Remove contact set attaching screw and lift contact point set from breaker plate.
3. Clean oil smudge and dirt from breaker plate.

IMPORTANT: Carefully wipe protective film from point set prior to installation.

4. Place a small amount of Distributor Cam Lubricant on distribor cam.
5. Place a new contact point assembly in position on breaker plate and install attaching screw.
6. Place primary terminal screw through condenser lead and point lead. Install primary screw through 2 insulator bushings in distributor housing. Install primary terminal lock nut, primary lead, and primary lead retaining nut to primary terminal screw.
7. Check points for proper alignment. If points do not align properly, replace with another set of points. (Figure 4)

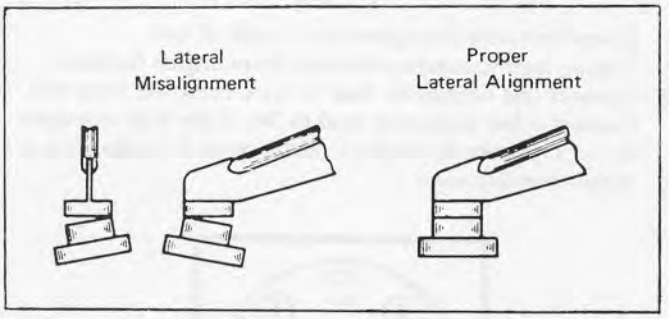
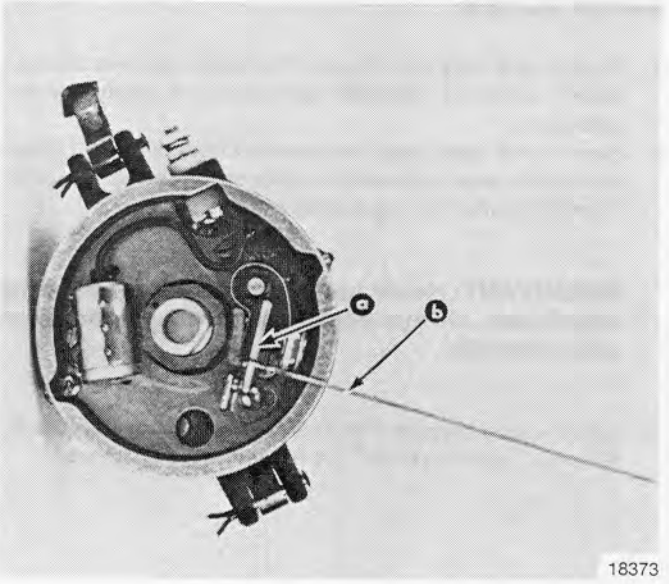


Figure 4

8. Check point spring tension (Figure 5).

Contact point spring tension must fall within specified limits. Weak tension will cause chatter which results in arcing and burning of points and an ignition miss at high speed, while excessive tension will cause undue wear of contact points, cam and rubbing block. Contact point tension should be checked with a spring gauge. Scale should be hooked to breaker lever and pull exerted at 90° to breaker lever. Reading should be taken just as points separate. Tension can be adjusted by bending breaker lever spring. If tension is excessive, it can be decreased by pinching spring carefully. To increase tension remove lever from distributor so that spring can be bent away from lever. Avoid excessive spring distortion.



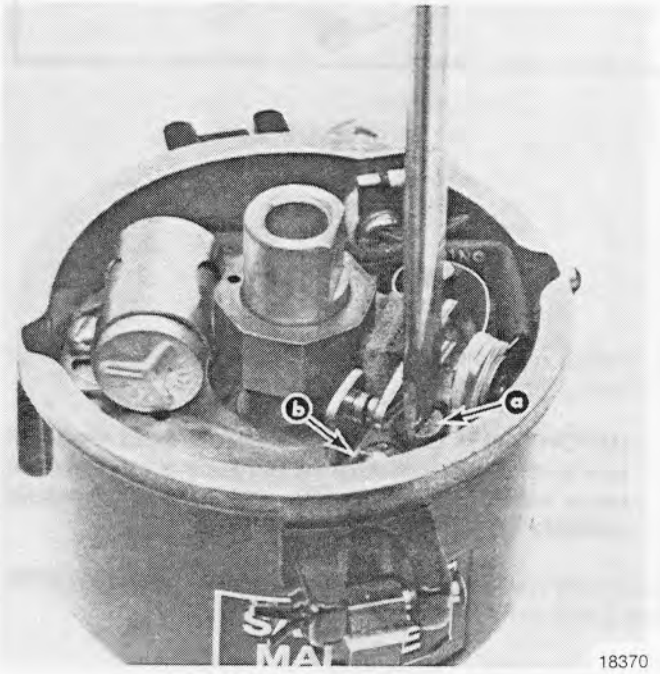
a - Movable Contact
b - Spring Tension Gauge

Figure 5. Checking Spring Tension

Point Adjustment with Feeler Gauge

IMPORTANT: Point gap (dwell) can be adjusted by 2 methods. It is preferred that points be adjusted with a feeler gauge, then checked with a dwell meter. Points, however, also can be adjusted, as well as checked, with a dwell meter: After points have been set, dwell should be checked with engine running.

1. Rotate distributor until rubbing block rests on peak of cam lobe, which will provide maximum breaker point opening.
2. Insert correct feeler gauge between breaker points.
3. Loosen lockscrew and adjust points to specifications (Figure 6).



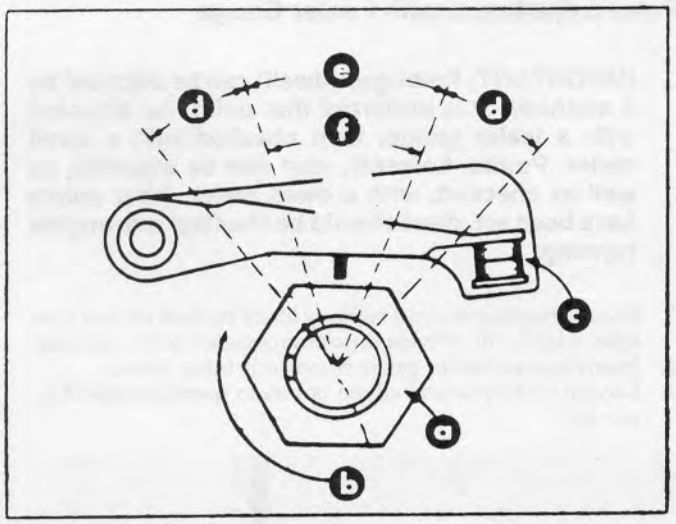
a - Adjustment Screw
b - Locking Screw

Figure 6. Point Adjustment

Dwell Adjustment

1. Remove distributor cap and rotor.
2. Connect positive (+) dwell meter lead to negative (–) side of coil. Connect negative (–) meter lead to ground.
3. Loosen point lock screw slightly.
4. While cranking engine with starter, adjust dwell with a screwdriver (Figure 6) to obtain reading on dwell meter, as specified in "Specifications', and tighten lockscrew. (Dwell reading will be unsteady using this method.)

IMPORTANT: Cam angle increases as point opening is decreased and vice versa. (Figure 7)



a - Cam
b - Direction of Rotation
c - Breaker Points
d - Points Open
e - Points Close
f - Cam Angle or Dwell

Figure 7. Cam Angle

5. Install rotor and distributor cap and recheck dwell with engine running.

IMPORTANT: Dwell should be checked between idle and 1750 RPM. Any dwell reading variations of more that 3° between idle and 1750 RPM would indicate wear in the distributor.

Cam angle readings, taken at speeds above 1750 engine RPM, may prove unreliable on some dwell meters.

CONDENSER

1. Use Magneto Analyzer for test.
2. Test condenser for the following:
   a. Condenser capacity test.
   b. Condenser leakage and short test.
   c. Condenser series resistance test.
3. Replace condenser if test results are not within specifications.

COIL

1. Use Magneto Analyzer for test.
2. Check coil for the following:
   a. Coil power test
   b. Coil surface insulation test
   c. Coil continuity test
   d. Primary resistance test
   e. Secondary resistance test
3. Replace coil if test results are not within specifications.

IGNITION RESISTANCE WIRE

Engine with Electric Choke

1. Disconnect wire from positive (+) side of coil.
2. Unplug quick disconnect (with 2 wires) from electric choke heater element.
3. Connect ohmmeter leads to ends of disconnected wires. Replace resistor wire if reading is not within specifications.
4. Reconnect wires to coil and choke.
5. For instructions on replacing resistor wire refer to "Section 3, Part E".

Engine without Electric Choke

1. Disconnect wire from positive (+) side of coil.
2. Unplug instrumentation harness from engine harness.
3. Connect one ohmmeter lead to wire removed from coil. Connect other ohmmeter lead to No. 5 pin hole in engine harness. (Figure 8) Replace reistor wire if reading is not within specifications.

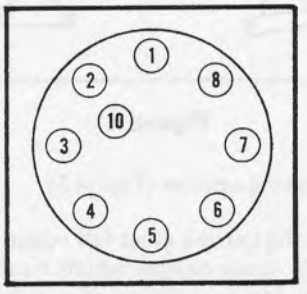


Figure 8. Engine Harness Connector

4. Reconnect wire to coil. Plug instrumentation harness onto engine harness and tighten retaining clamp securely.
5. For instructions on replacing resistor wire refer to "Section 3, Part E".

SPARK PLUGS

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number or heat range. Refer to "Specifications" for spark plug numbers.

IMPORTANT: Never bend the center electrode to adjust gap. Always adjust by bending ground or side electrode.

3. Adjust spark plug gaps with a round feeler gauge. (Figure 9) Refer to "Specifications" for proper spark plug gap.

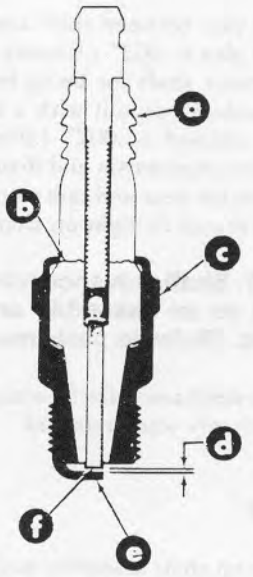
4. Clean spark plug seating area. DO NOT use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas-tight seal in cylinder. For this reason, as well as necessity of maintaining correct plug gap, correct torque is very important during installation.

IMPORTANT: Tapered seat spark plugs are not interchangeable with nontapered (with gasket) spark plugs.

HIGH TENSION LEADS

1. Inspect high tension leads for damage.
2. Check high tension leads for continuity.
3. Replace any leads that are cracked, cut, or have damaged spark plug boots.
4. Replace any leads that do not show continuity from end to end.
5. Reinstall high tension leads in proper order.

IMPORTANT: Proper positioning in high tension lead supports is important to prevent cross firing.



a - Porcelain Insulator
b - Insulator Cracks Often Occur at this Point
c - Shell
d - Proper Gap
e - Side Electrode (File Flat When Adjusting Gap - Do Not Bend)

Figure 9. Spark Plug Detail

DISTRIBUTOR REPAIR

REMOVAL

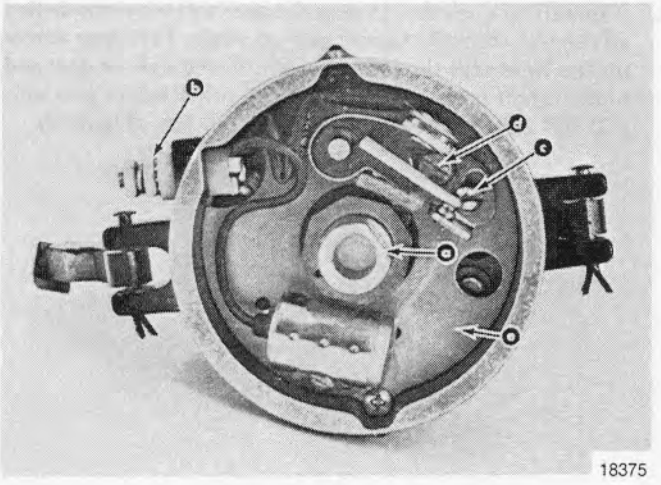
1. Remove distributor cap (2 screws) and gasket. Do not remove plug wires from cap unless necessary.
2. Disconnect coil primary lead from distributor.
3. Crank or turn engine slowly. Align timing marks when rotor is pointing to No. 1 terminal of distributor cap. If same distributor is to be reinstalled in engine, mark position of distributor housing in relation to engine so that distributor may be installed in same position.
4. Remove distributor retaining clamp.
5. Remove distributor.

IMPORTANT: To simplify distributor installation, DO NOT turn crankshaft with distributor removed from engine.

DISASSEMBLY

IMPORTANT: It is not necessary to disassemble distributor any further than required to complete repairs.

1. Lift rotor off of distributor shaft.
2. Remove condenser and breaker points and test as previously outlined. (Figure 1)
3. Mark breaker plate location and remove 2 retaining screws. Remove breaker plate. (Figure 1)
4. Remove pin from driven gear and shaft and remove gear from shaft.



a - Rotor Alignment Notch
b - Primary Terminal
c - Breaker Point Attaching Screw
d - Breaker Point Adjustment Screw
e - Breaker Plate

Figure 1. Breaker Plate Assembly

5. Remove washer(s) from shaft. (If there are 2 washers, the steel washer goes towards housing and the brass washer towards gear.)

IMPORTANT: Housing bushings are not serviced separately. (Refer to parts manual.)

6. Check for side play between shaft and housing bushings. Maximum side play is .002" (.05mm).
7. Remove and check shaft for being bent by placing in V-blocks and checking run out with a dial indicator. Maximum run out allowed is .002" (.05mm) (retain washer between advance mechanism and distributor housing).
8. Check cam lobes for wear and cam should fit tight on shaft. Advance plate should fit tight on shaft.

IMPORTANT: Shaft, advance mechanism and cam are serviced as an assembly and should not be disassembled. (Refer to parts manual).

9. Check advance mechanism for free movement. Mechanism should return freely when released.

REASSEMBLY

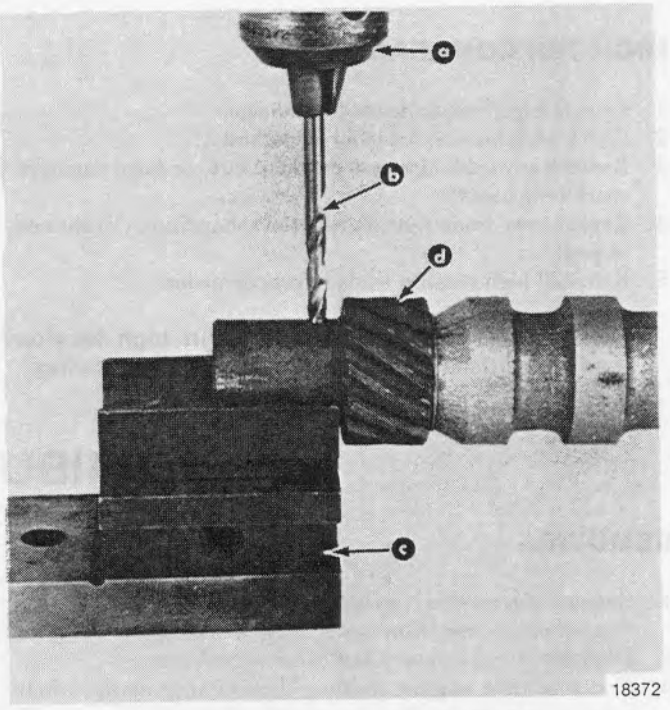
1. Install washer on shaft assembly and lubricate shaft with engine oil. Install shaft in housing.
2. Install washer(s) on shaft between housing and gear (if there are 2 washers, steel goes toward housing and brass goes toward gear).
3. If installing original driven gear slide onto shaft and install roll pin.

IMPORTANT: Hole in gear is offset, gear will fit on shaft and line up with hole only one way.

4. If installing a new driven gear the gear will not come drilled all the way through. Install gear on shaft. Turn gear to line up the hole with the hole in shaft. Using hole in gear and hole in shaft as a guide, drill through other side of gear with a 3/16" carbide tipped drill, install roll pin. (Figure 2)

IMPORTANT: If new gear has only a dimple, you will have to drill through one side of the gear before you slide gear onto shaft. In most cases it is recommended to have a machine shop complete the drilling operation for new gear installation.

5. Install breaker plate using alignment mark to properly locate.
6. Install points, condensor, and primary terminal screw.
7. Install distributor as outlined in "Distributor Installation".



a - Drill Press
b - 3/16" Carbide Tip Drill
c - V-Block
d - New Gear

Figure 2. Installing New Gear

DISTRIBUTOR INSTALLATION

ENGINE NOT DISTURBED

1. Install new gasket on distributor housing.
2. Turn rotor approximately ⅛-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

   IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil. Also install spark plug and coil secondary wires, if removed.

   IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Refer to "Specifications", for firing order.

5. Set point gap and dwell.
6. Install rotor and cap.
7. Time ignition as outlined under "Ignition Timing."

ENGINE DISTURBED

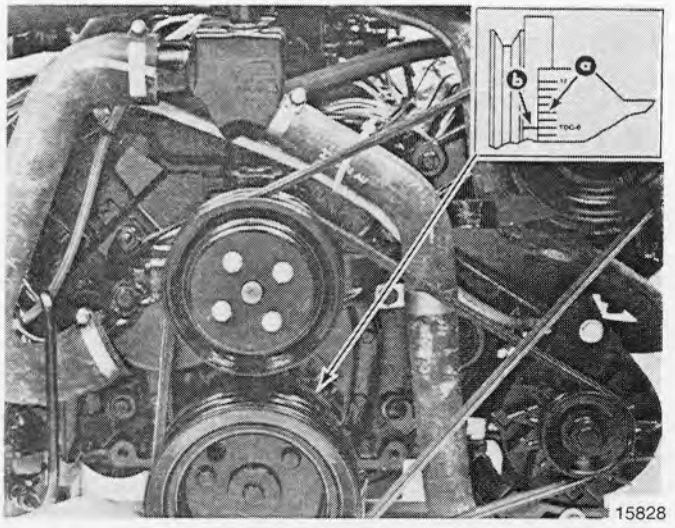
1. Locate No. 1 piston in firing position by either of 2 methods.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley or . . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately ⅛-turn more and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install cap, distributor primary lead to coil. Check all high tension wire connections and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Refer to "Specifications" for firing order.
8. Set point gap and dwell.
9. Time ignition as outlined under "Ignition Timing",

IGNITION TIMING

IMPORTANT: Dwell must be set to specification before adjusting timing.

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to battery (12 volts). Refer to "Specification" for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft harmonic balancer.
5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up with mark on tab specified in "Specifications". Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

IMPORTANT: GM engine timing marks (on tab) are in 2° increments. MCM and MIE L.H. engines will have the "A" (Advance) mark to the left of "O". MIE R.H. engines will have the "A" mark to the right of "O". Timing must be set on the "A" side of "O" (Top Dead Center).



a - Degree Marks
b - Timing Marks

Figure 1. Timing Tab on "GM" V-8 Engine

THUNDERBOLT IV (HEI) SYSTEM
TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Distributor Clamp 3/8 - 16	20 (27)
Spark Plugs (14mm)	15 (20)

TOOLS/LUBRICANTS/SEALANTS

TOOLS	
91-52024A1	Remote Starter Switch
91-63998	Spark Gap Tester
91-99379	Timing Light
91-63209	Torch Lamp
91-99750	Volt/Ohmmeter

LUBRICANTS/SEALANTS	
92-90018	2-4-C Lubricant
92-41669	Insulating Compound
92-25711	Liquid Neoprene
92-32609	Quicksilver Loctite "A"

SPECIFICATIONS

UNIT OF MEASUREMENT
in. (mm)

COIL

Coil Part Number	392-7803
Primary Resistance*	.60 - .80 Ohms
Secondary Resistance*	9,400 - 11,700 Ohms

*NOTE: * Use magneto analyzer*

TIMING

Model	MCM 898R	MCM 228R	MCM 260R	330 (B-W)	MIE 230	MIE 260	MIE 340
Timing	8° BTDC						

SPARK PLUGS

Model	MCM 898R	MCM 228R	MCM 260R	MCM 330 BW	MIE 230	MIE 260	MIE 340
Spark Plug Gap	.035 (.9)						
Spark Plug Type	AC-MR43T/Champion-RV8C Autolite-144/NGK-BR6FS						

FIRING ORDER

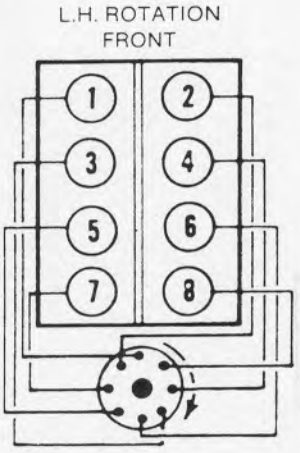


Figure 1. MCM 898/228R/260R/330 (B-W) MIE/230/260/340 L.H. (Standard) Rotation

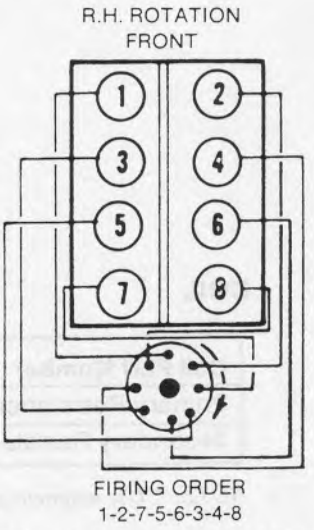


Figure 2. MIE 230/260/340 R.H. (Opposite) Rotation

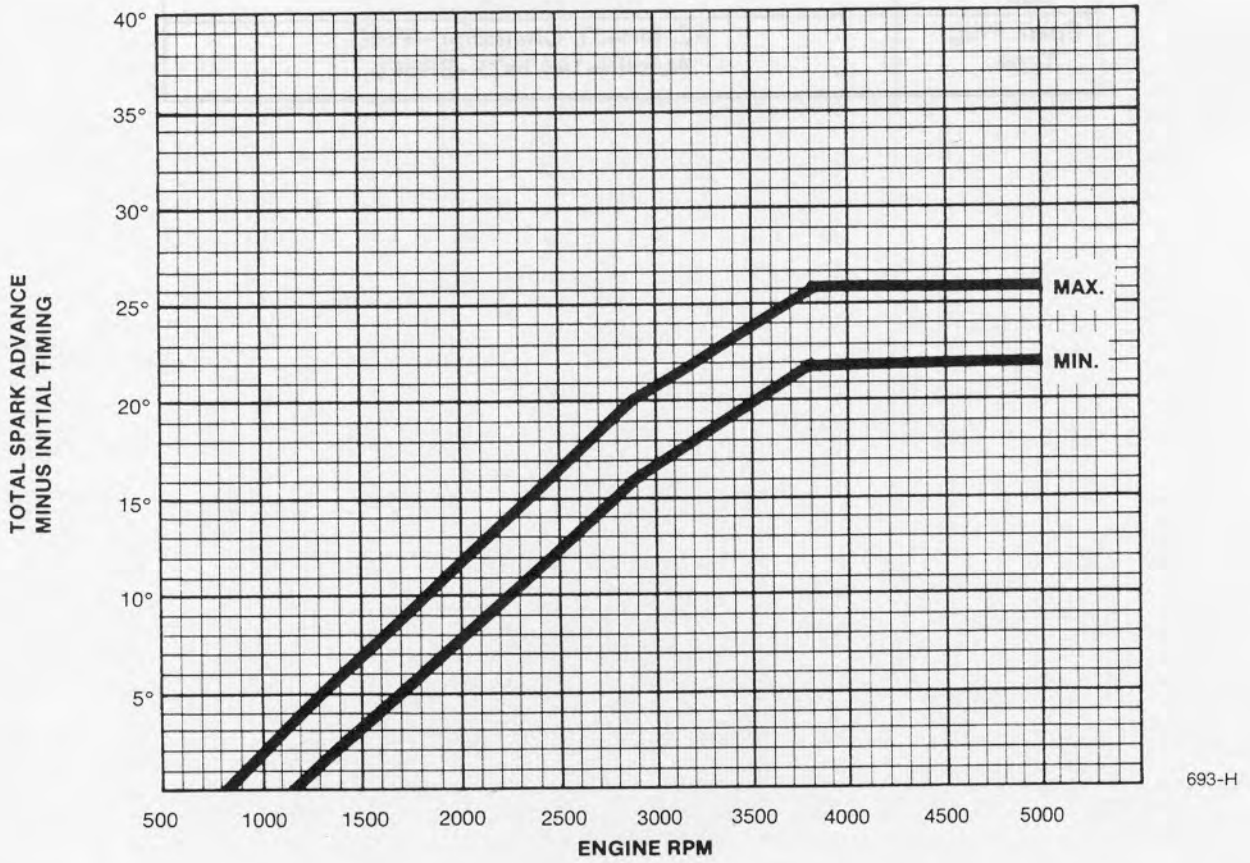
DISTRIBUTOR ADVANCE CURVE

IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.

EXAMPLE: On the advance curve chart a 260R shows 19° spark advance at 2900 R.P.M. Add 8° BTDC initial timing for a 260R and total spark advance at 2900 R.P.M. is 25°.

IMPORTANT: On the HEI ignition the spark advance is controlled by the amplifier.

MCM 898R/228R/260R/330 (B-W)
MIE 230/260/340



REPAIR

PRECAUTIONS

⚠WARNING

When performing the following procedure, be sure to observe the following.

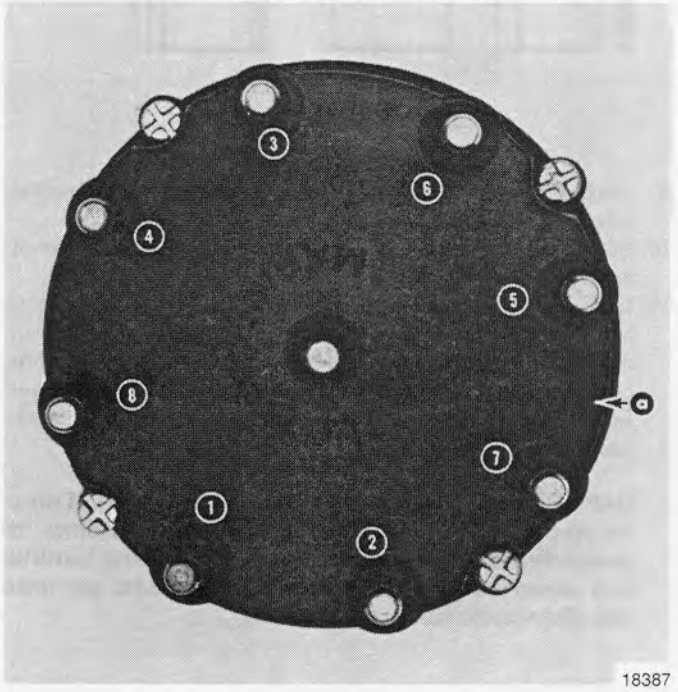
- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet, and clothing clear of engine moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (-) ground.**
- **Do not disconnect battery cables while engine is running.**

DISTRIBUTOR CAP

1. Loosen four distributor cap retaining screws.
2. Remove distributor cap.

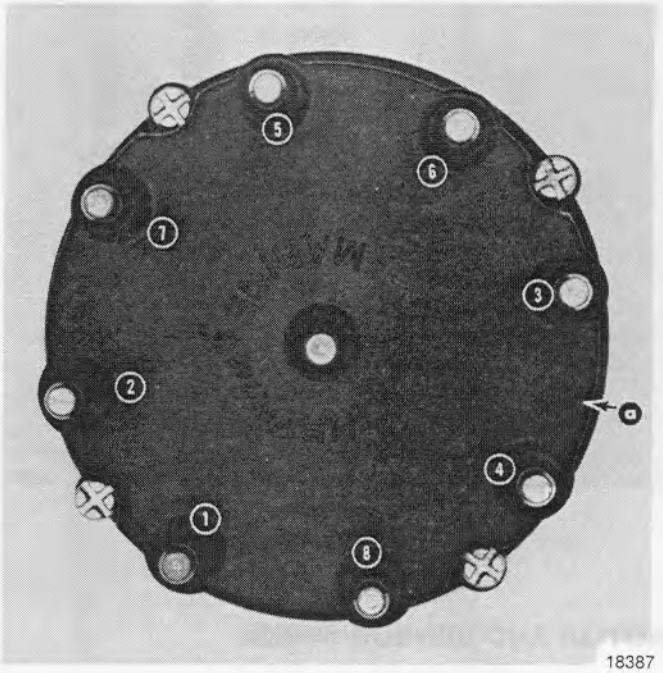
IMPORTANT: If high tension leads are removed from cap refer to Figure 1 or 2.

3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contacts for excessive burning or corrosion. Check center contact for deterioration.
5. Check cap for cracks or carbon tracks using Magneto Analyzer.



a - Alignment Notch

Figure 1. L.H. Rotation Wiring



a - Alignment Notch

Figure 2. R.H. Rotation Wiring

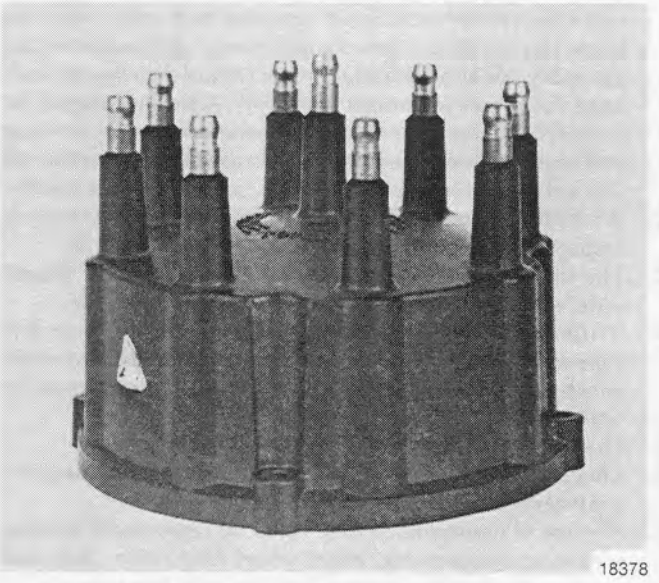
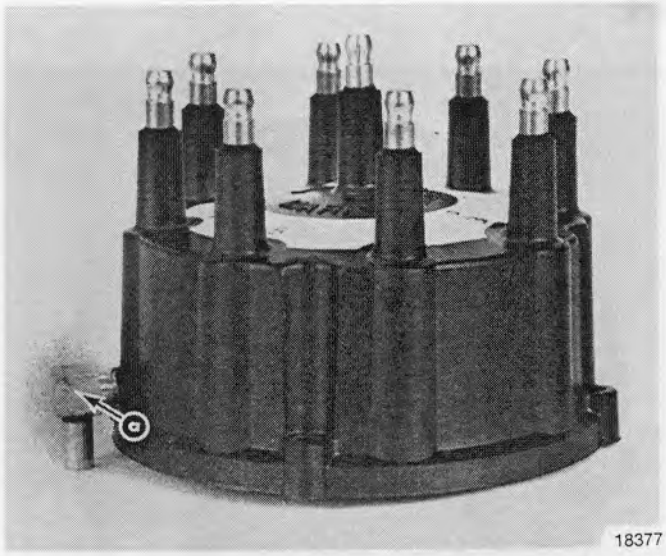


Figure 3. Non Vented Cap



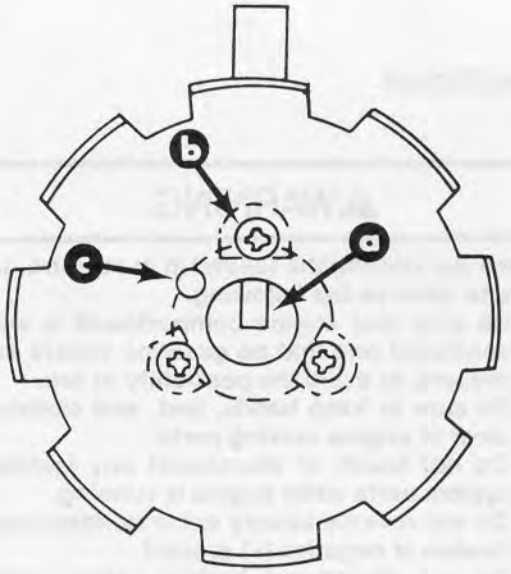
a - Vent

Figure 4. Vented Cap

ROTOR AND SENSOR WHEEL

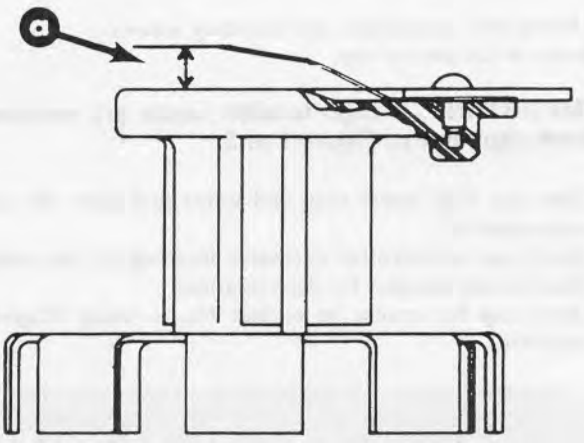
1. Remove distributor rotor/sensor wheel assembly from distributor shaft. Rotor and sensor wheel are Loctited onto shaft. Use two ⅜" (10mm) wide flat blade screwdrivers approximately 8" (203mm) to 10" (254mm) long. The screwdrivers are positioned opposite each other with the blade tips on the underside of the rotor and sensor wheel assembly. Make sure blade tips are toward distributor shaft until they come in contact with shaft. A downward push on both screwdriver handles at the same time will pry rotor and sensor wheel assembly off. The use of Torch Lamp will also aid in the removal of the rotor/sensor wheel assembly.
2. With the rotor and sensor wheel assembly removed, inspect the locating key inside the rotor. (Figure 5)
3. The locating key will appear as a clean edged, ⅛" (3mm) wide, sloped ramp at the bottom of the splined hole.
4. If there are pieces of material shaved off of key or if it appears to have been damaged by being forced down while misaligned with slot in distributor shaft, the rotor must be replaced.
5. Check rotor for burned or corroded center contact.
6. Check rotor for cracks and carbon tracks using magneto analyzer and instructions supplied with analyzer.
7. If rotor is damaged, replace rotor by removing 3 phillips screws and separating sensor wheel from rotor. Reinstall sensor wheel to new rotor making sure locating pin on rotor is installed in locating hole in sensor wheel. Tighten 3 phillips screws securely. (Figure 5)
8. Bend carbon brush tang upward slightly until a distance of ¼" (6.5mm) is obtained between rotor and tang. (Figure 6)

IMPORTANT: if there is any doubt if sensor wheel is located properly, you can lay sensor wheel on top of Figure 5 with sensor fingers facing up (toward you). Line up 3 screw holes and locating pin hole on sensor wheel with Figure. If wheel is indexed properly all the fingers on wheel will line up with the one in the Figure.



a - Locating Key
b - Phillips Screws
c - Sensor Wheel Locating Pin

Figure 5. Locating Key Location



a - 1/4" (6.5mm)

Figure 6. Rotor Assembly

9. Put 2 drops of Loctite 271 or Loctite Type "A" into the rotor so it lands on the locating key. (Figure 5)
10. Put 2 drops of Loctite in keyway on upper portion of distributor shaft. (Figure 7)
11. Immediately install rotor assembly onto distributor shaft. MAKE SURE rotor locating key is aligned with keyway in distributor shaft BEFORE pressing rotor all the way down on shaft until it stops with the palm of your hand. Let Loctite cure overnight with distributor in inverted position.

IMPORTANT: The rotor should fit very tight. It may be necessary to heat rotor with Torch Lamp to properly install. It is important not to let any Loctite run down distributor shaft. Loctite could get into top distributor housing bushing.

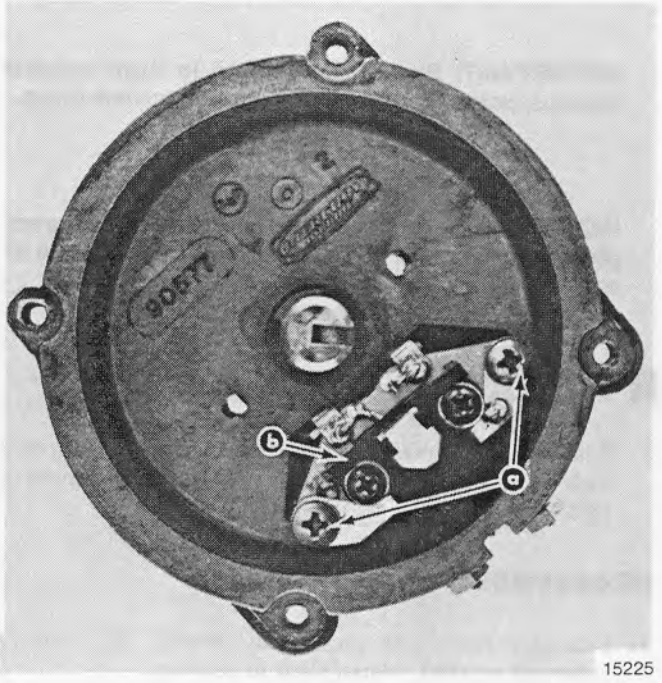
12. Reinstall distributor cap on distributor.
13. Install spark plug wires (if removed) as shown in Figure 1 or 2. Apply a small quanity of Insulating Compound to the inside of each spark plug wire boot before installing the boot on distributor cap. Wipe off excess. This Insulating Compound will help "waterproof" this area of the ignition system.

IMPORTANT: Make sure boot DOES NOT "hydraulic" back off of distributor cap terminal. If it does, use needle nose pliers and bend metal spark plug wire terminal (inside of boot) slightly so it grips the distributor cap terminal tighter.

IMPORTANT: Black boot is distributor end of spark plug wire. Gray (or Red) boot is spark plug end of wire.

SENSOR

1. Remove rotor and sensor wheel.
2. Remove 2 screws that hold sensor into distributor housing. (Figure 7)
3. Remove sensor from housing.



15225

a - Mounting Screws
b - Sensor Assembly

Figure 7

4. Use a good magnifying glass and light to inspect the two metal "jumper leads" for cracks (Figure 8). If a crack is found in either metal "jumper lead", install a new sensor.

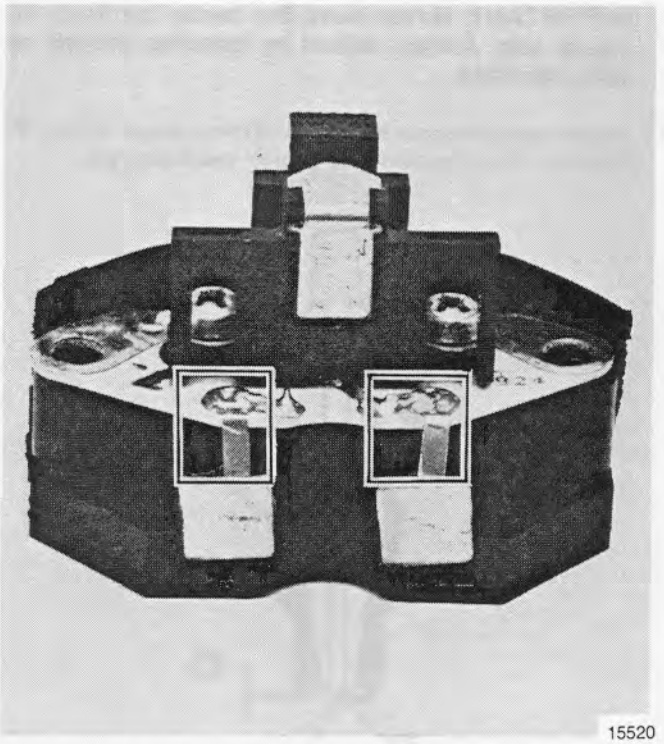

15520

Figure 8. Location of Cracks in Metal Jumper Leads on Ignition Sensor

⚠CAUTION

DO NOT USE any type of silicone sealer on the inside of the distributor. Most silicone sealers give off an acidic vapor during the curing stage of the sealer. This acidic acid can cause corrosion on the ignition components.

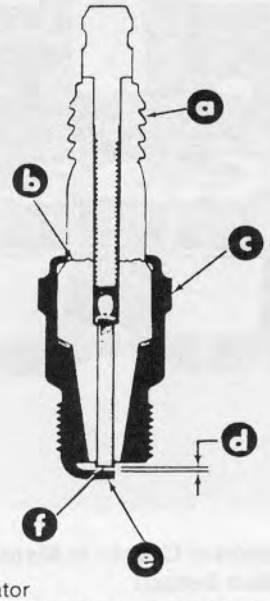
5. Install sensor into housing and install 2 retaining screws.
6. Install sensor wheel, rotor, and distributor cap.

SPARK PLUGS

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number or heat range. Refer to "Specifications" for spark plug numbers.

IMPORTANT: Never bend the center electrode to adjust gap. Always adjust by bending ground or side electrode.

3. Adjust spark plug gaps with a round feeler gauge. (Figure 9) Refer to "Specification" for proper spark plug gap.



a - Porcelain Insulator
b - Insulator Cracks Often Occur at this Point
c - Shell
d - Proper Gap
e - Side Electrode (Bend to Adjust Gap)
f - Center Electrode (File Flat When Adjusting Gap - DO NOT Bend)

Figure 9. Spark Plug Detail

4. Clean spark plug seating area. DO NOT use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas-tight seal in cylinder. For this reason, as well as necessity of maintaining correct plug gap, correct torque is very important during installation.

IMPORTANT: Tapered seat spark plugs are not interchangeable with nontapered (with gasket) spark plugs.

HIGH TENSION LEADS

1. Inspect high tension leads for damage.
2. Check high tension leads for continuity.
3. Replace any leads that are cracked, cut, or have damaged spark plug boots.
4. Replace any leads that do not show continuity from end to end.
5. Reinstall high tension leads in proper order.

IMPORTANT: Proper positioning in high tension lead supports is important to prevent cross-firing.

IMPORTANT: Black boot is distributor end of spark plug wire. Gray (or Red) boot is spark plug end of wire.

DISTRIBUTOR REPAIR

REMOVAL

1. Remove distributor cap. Do not remove high tension leads unless necessary.
2. Crank engine over until timing marks line up and rotor is pointing towards No. 1 cylinder on distributor cap.
3. Mark distributor housing in reference to engine block.
4. Remove bolt and hold down clamp and remove distributor.

IMPORTANT: To simplify distributor installation, DO NOT turn crankshaft with distributor removed from engine.

DISASSEMBLY

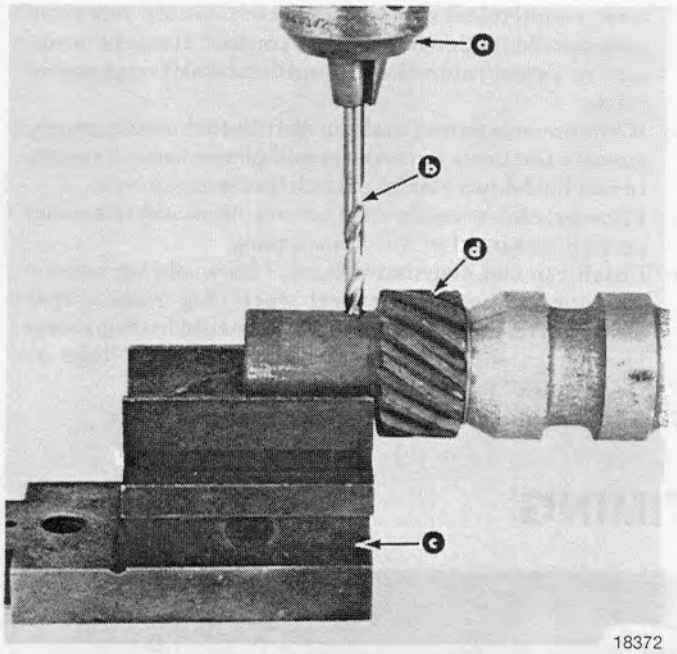
1. Remove rotor, sensor wheel, and sensor as previously outlined.
2. Remove roll pin, washer and driven gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is .002" (.05mm).
4. Remove shaft from housing and check shaft for being bent with a dial indicator and V-blocks. Maximum runout is .002" (0.5mm).

REASSEMBLY

1. Lubricate shaft with engine oil. Install "E" clip (if removed) on shaft. Install shaft in housing.
2. Install washer on shaft. Install original gear slide onto shaft and install roll pin.

IMPORTANT: Hole may be offset and gear will only fit in one direction.

3. If installing a new gear, the gear will come drilled on one side. Slide gear onto shaft, line hole in gear with hole in shaft. Using these holes as guides, drill through other side of gear with a 3/16" carbide tipped drill.

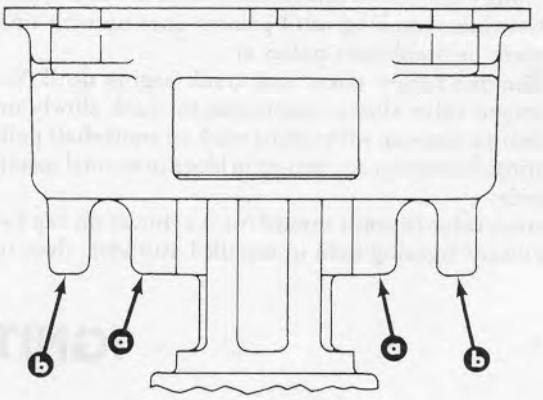


a - Drill Press
b - 3/16" Carbide Tip Drill
c - V-Block
d - New Gear

Figure 1. Drilling New Gear

4. Install sensor, sensor wheel, and rotor as previously outlined.
5. Install distributor as outlined in "Distributor Installation".

IMPORTANT: Early HEI Ignition systems had 2 vents in distributor housing. Later ignition systems and all replacement housings have 4 vents. (Figure 2)



a - 2 Vent Type
b - Added These Vents to Make Distributor a 4 Vent Type

Figure 2. HEI Distributor Base

⚠WARNING

DO NOT DRILL additional vent holes or modify 2 vent type distributor in any way to try and make it a 4 vent type.

DISTRIBUTOR INSTALLATION

ENGINE NOT DISTURBED

1. Install new gasket on distributor housing.
2. Turn rotor approximately ⅛-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect leads. Also install spark plug and coil secondary wires, if removed.

IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Refer to "Specifications", for firing order.

5. Install cap.
6. Time ignition as outlined under "Ignition Timing".

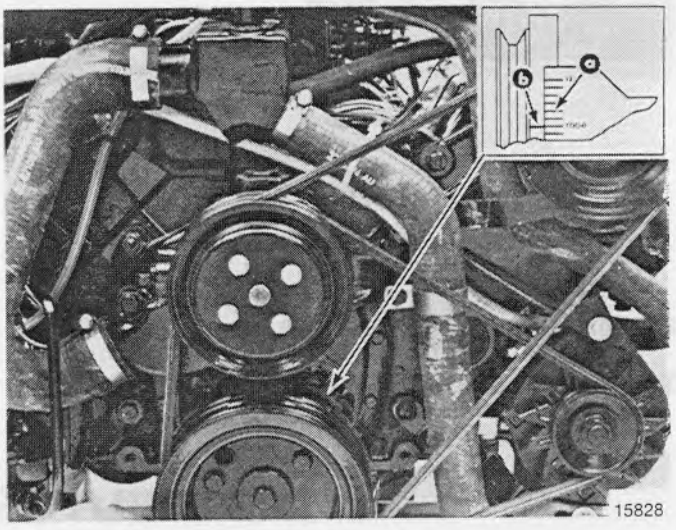
ENGINE DISTURBED

1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley or . . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately ⅛-turn more and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
6. Install cap and distributor leads. Check all high tension wire connections and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Refer to "Specifications" for firing order.
7. Time ignition as outlined under "Ignition Timing".

IGNITION TIMING

1. Connect timing light to No. 1 spark plug. Conncect power supply leads on light to battery (12 volts). Refer to "Specifications" for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft harmonic balancer.
5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up with mark on tab specified in "Specifications". Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

IMPORTANT: GM engine timing marks (on tab) are in 2° increments. MCM and MIE L.H. engines will have "A" (Advance) mark to the left of "O". MIE R.H. engines will have the "A" mark on the right of "O". Timing must be set on the "A" side of "O" (Top Dead Center).



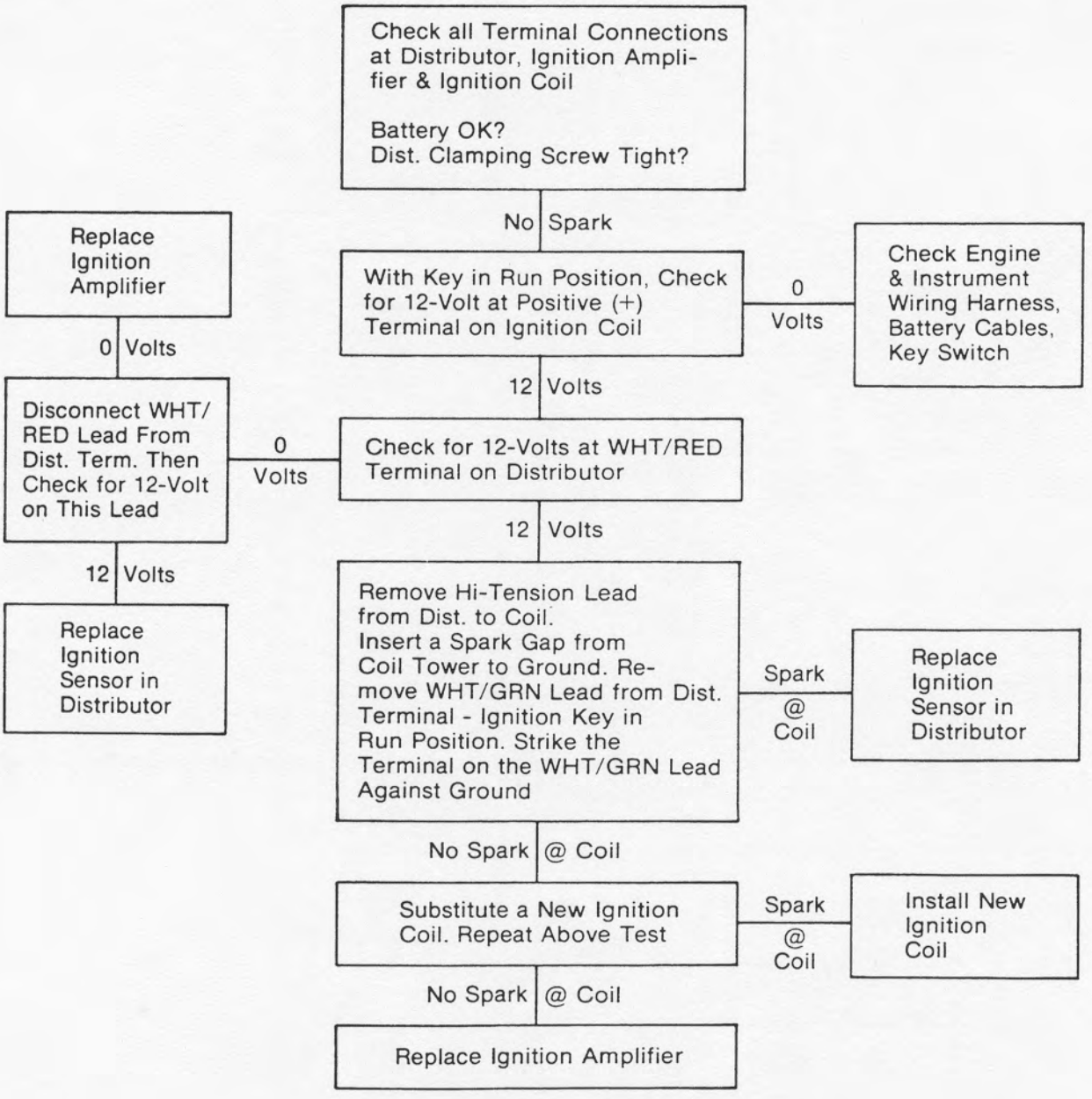
a - Degree Marks
b - Timing Mark

Figure 1. Timing Tab on "GM" V-8 Engine

THUNDERBOLT IV TESTING

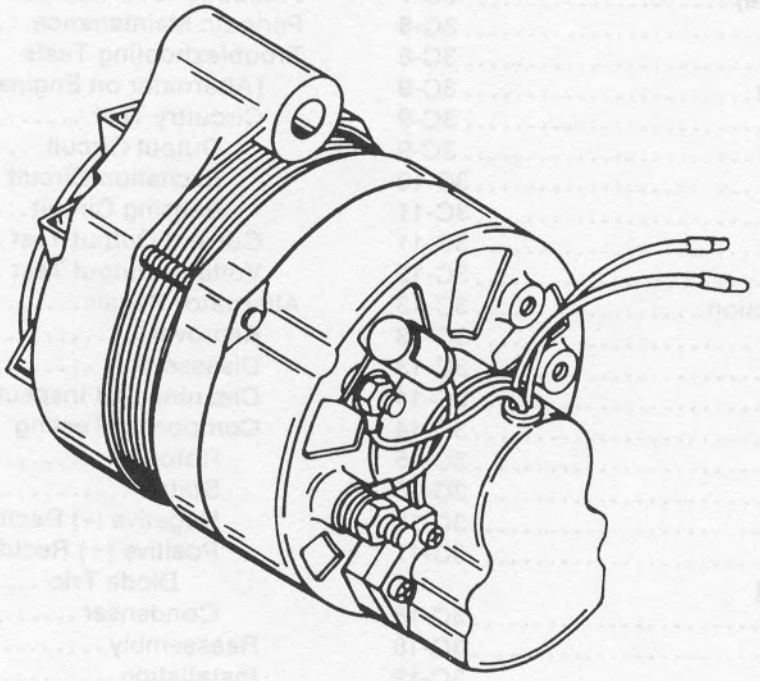
⚠WARNING

Be sure that engine compartment is well ventilated and that there are no gasoline vapors present during the following test - to prevent a potential fire hazard.



SECTION 3 - ELECTRICAL SYSTEM

PART C - CHARGING SYSTEM



MERCURY MARINE
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STERN DRIVES & INBOARDS

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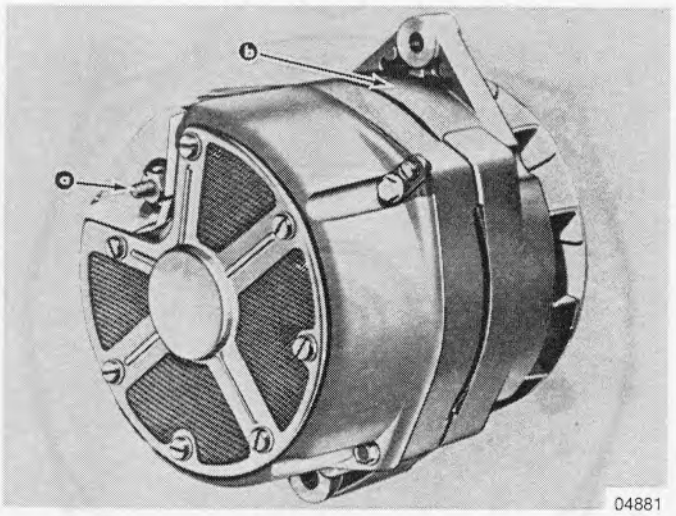
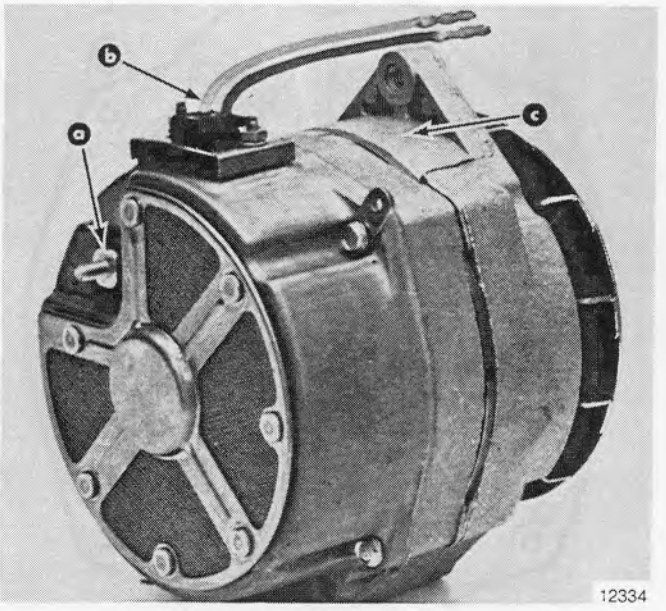
IDENTIFICATION



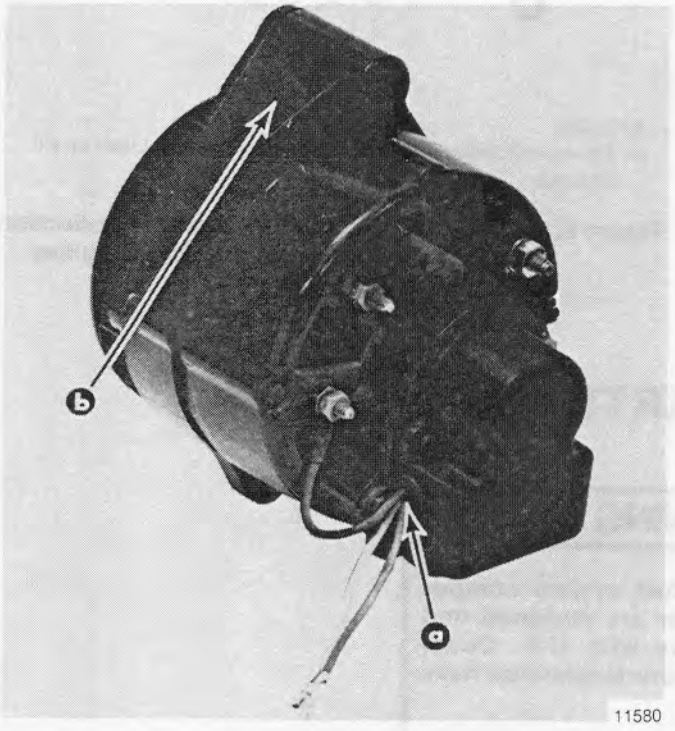
a - Output Terminal
b - Delco Number

Figure 1. Delco 1-Wire



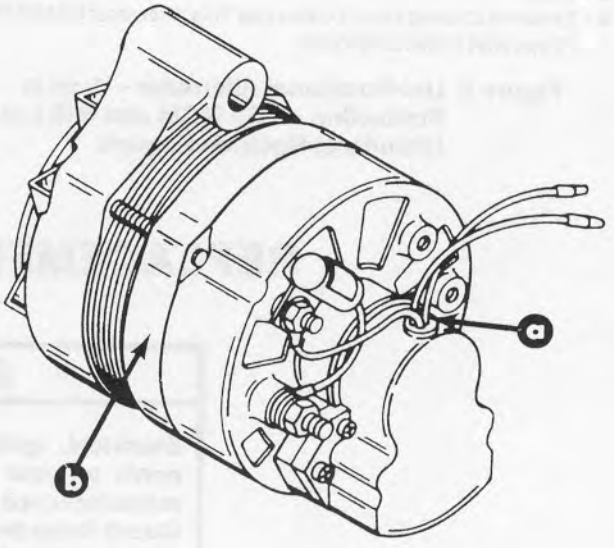
a - Output Terminal
b - 2 Wires Going to Engine Harness
c - Delco Number

Figure 2. Delco 3-Wire



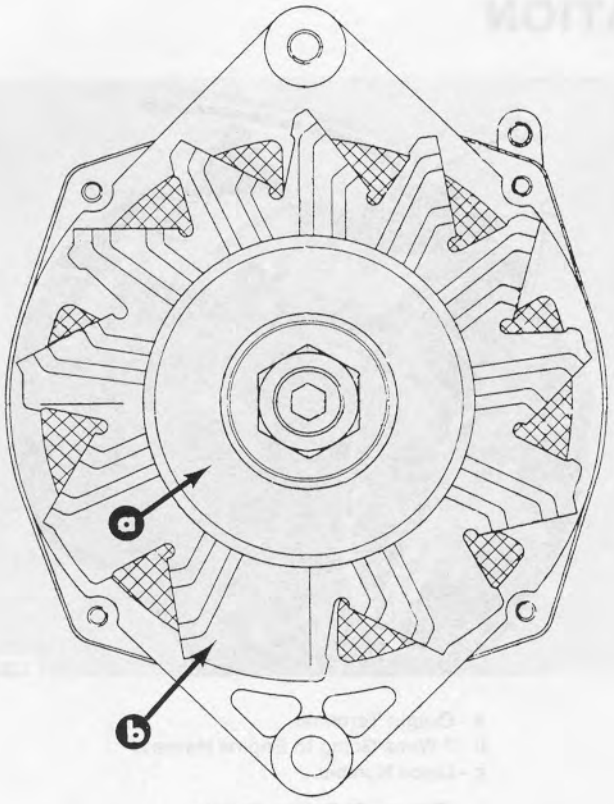
a - 2 Wires Going to Engine Harness Coming Out the Side of Regulator
b - Motorola Number

Figure 3. Motorola



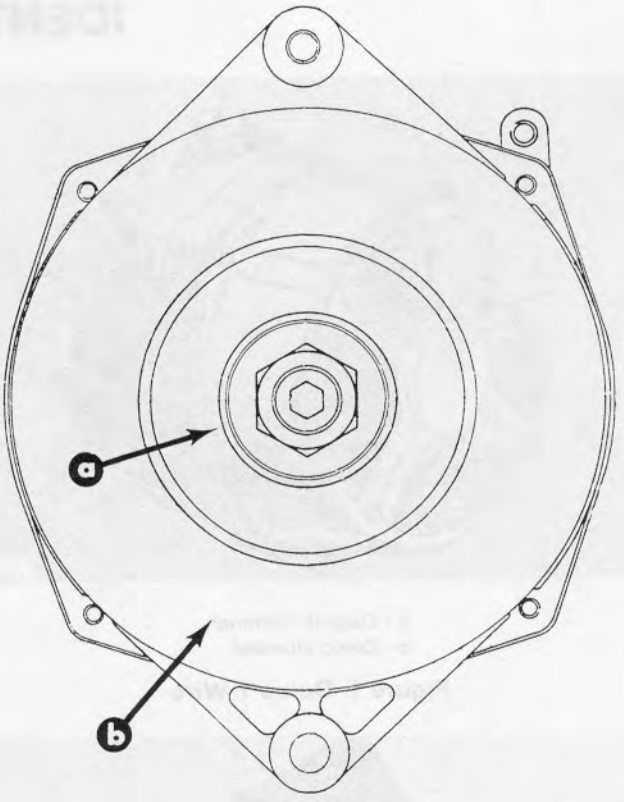
a - 2 Wires Going to Engine Harness Coming Out the Top of Regulator
b - Mando Number

Figure 4. Mando



a - Pulley
b - Exposed Cooling Fins - Do Not Use This Alternator On MIE R.H. (Opposite) Rotation Engines

Figure 5. Uni-Rotational Alternator - Used in Production on All MCM and MIE L.H. (Standard) Rotation Engines



a - Pulley
b - Covered Cooling Fins - this Alternator Can Be Used on All Engines

Figure 6. Bi-Rotational Alternator - Used in Production on MIE R.H. (Opposite) Rotation Engines and as Service Replacement

REPLACEMENT PARTS WARNING

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

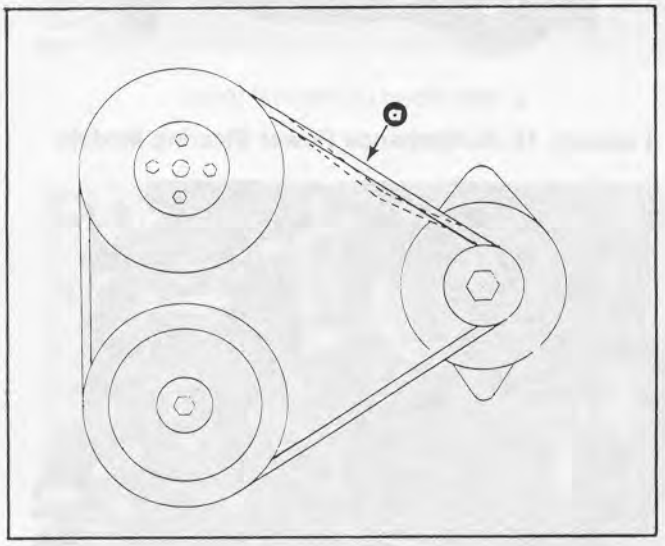
Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

IMPORTANT: Alternators are equipped with an excitation circuit. This circuit will have approximately a 7 milli amp draw on the battery with the ignition key in the off position. This draw is normal.

DRIVE BELT TENSION ADJUSTMENT

ALTERNATOR

1. Install drive belt on pulleys and adjust tension as follows. (Figure 1)
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown in Figure 1.
   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolts.



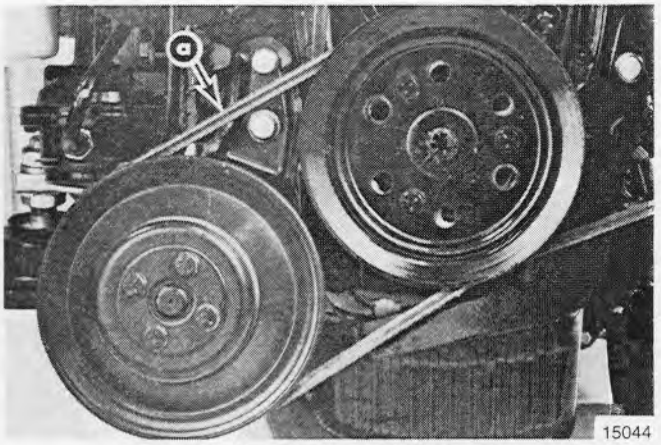
a - Belt Should Depress 1/2" (13mm)

Figure 1. Alternator Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

SEAWATER PICKUP PUMP

1. Install drive belt on pulleys and adjust tension as follows. (Figure 2)
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown in Figure 2.
   b. After obtaining correct tension, securely retighten pump brace and pump mounting bolts.



a - Belt Should Depress 1/4" (6mm)

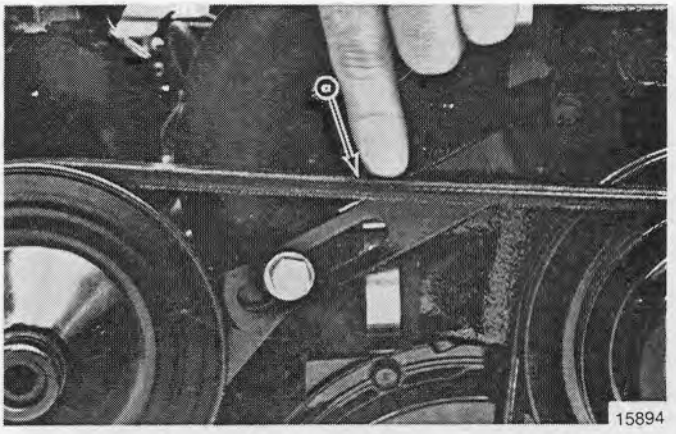
Figure 2. Seawater Pump Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

POWER STEERING PUMP

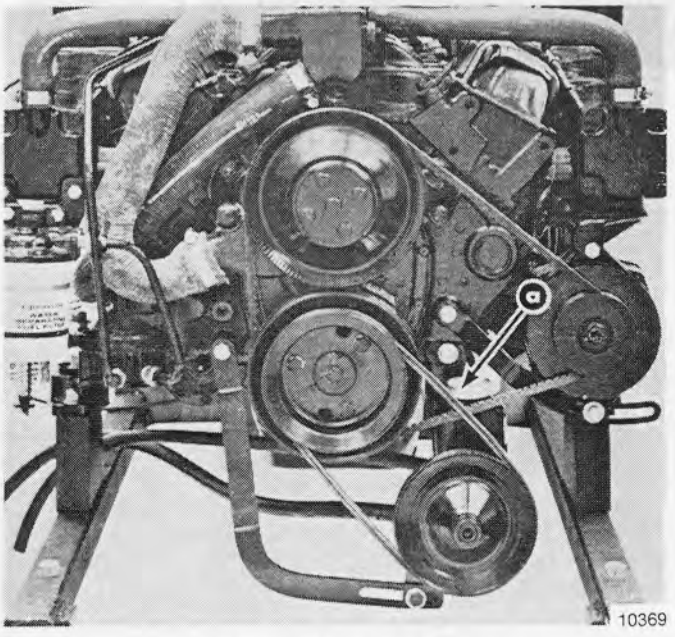
IMPORTANT: DO NOT pry on pump with pry bar or screwdriver.

1. Install drive belt on pulleys and adjust tension as follows. (Figures 3, 4, 5, 6, 7 or 8)
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown.
   b. After obtaining correct tension, securely retighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.



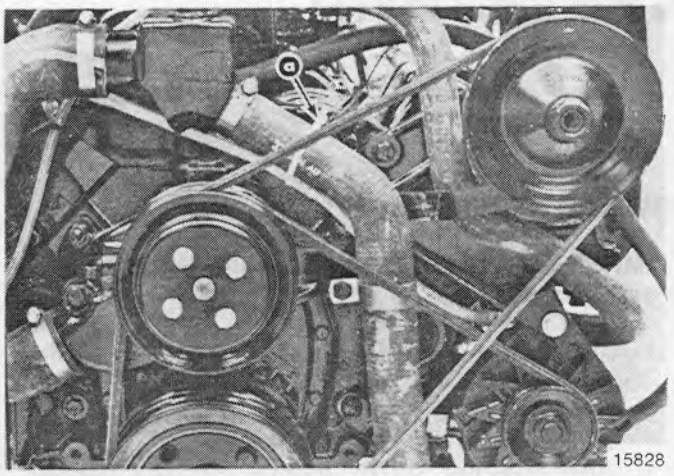
a - Belt Should Depress 1/4" (6mm)

Figure 3. MCM 120/140/165



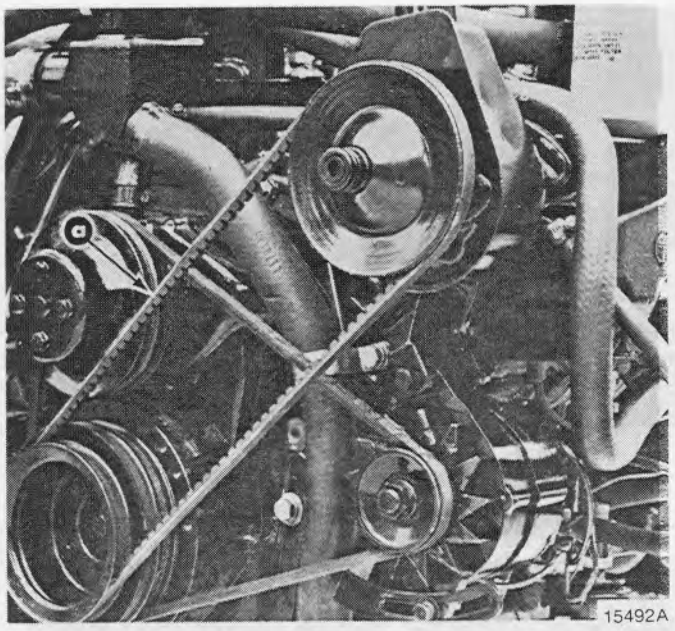
a - Belt Should Depress 1/4" (6mm)

Figure 4. MCM 898/228/260/330 With Low Mounted Pump



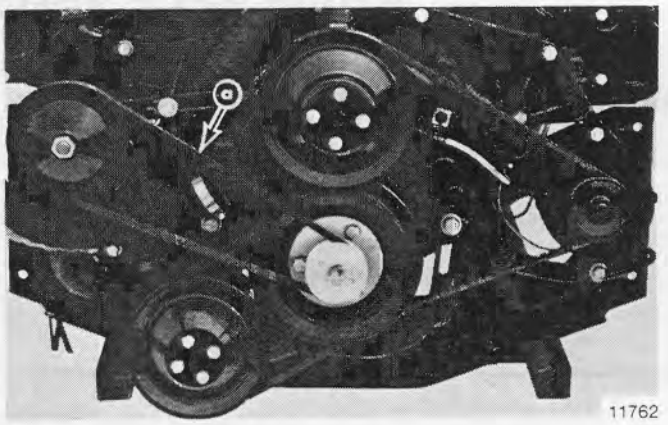
a - Belt Should Depress 1/4" (6mm)

Figure 5. MCM 898/228/260 With High Mounted Pump



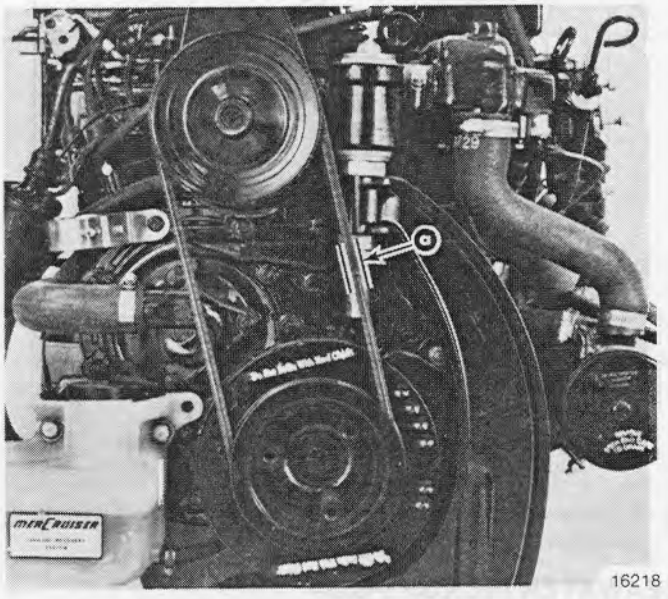
a - Belt Should Depress 1/2" (13mm)

Figure 6. MCM 330 (B-W)



a - Belt Should Depress 1/4" (6mm)

Figure 7. Hi-Performance Power Steering Models



a - Belt Should Depress 1/4" (6mm)

Figure 8. MCM 470/485/488

MOTOROLA ALTERNATOR

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace To Alternator		192 (28)
Alternator Brace To Block	30 (41)	
Alternator To Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
Brush Retaining Screws	Securely	
Diode Trio Studs	Securely	
Pulley Nut	50 (68)	
Rectifier Diode Studs	Securely	
Regulator Retaining Screws	Securely	
Slip Ring Retaining Bolt	Securely	
Thru Bolts	Securely	

TOOLS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-31229A5	Bearing Removal and Installation Kit
91-76032	Magneto Analyzer
91-37241	Universal Puller Plate
91-99750	Volt/Ohmmeter

TOOLS PURCHASED LOCALLY
Ammeter (0-50 Amps)

SEALANTS	
92-25711	Quicksilver Liquid Neoprene

SPECIFICATIONS

Mercury Number (Motorola Number)	Amp Output (Max.)	Rotation
78402 (8MR2024F)	37	Bi-Rotational
78403 (8MR2023F)	37	Uni-Rotational
92497 (8MR2039K)	55	Bi-Rotational
92498 (8MR2036K)	55	Uni-Rotational

DESCRIPTION

The alternator system, used on engines with Motorola Alternators, consists of the alternator, battery, the ignition switch and the wiring which connects these components. Refer to "Section 3 Part F" for wiring diagrams.

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven (via a pulley) at approximately twice engine speed. The rotor contains a field winding that is enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 insulated slip rings on the rotor shaft. Current is supplied to the field winding by 2 brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 6 diodes which are arranged so that current flows from ground, thru the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifier and stator. A capacitor also is utilized to protect the rectifier system from high voltages and to suppress radio noise.

PRECAUTIONS

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the "Troubleshooting Test".
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (–) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the negative (–) (grounded) battery cable to negative (–) battery terminal and the positive (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

PERIODIC MAINTENANCE

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connections.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under "Drive Belt Tension Adjustment".
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.

TROUBLESHOOTING TESTS (ALTERNATOR ON ENGINE)

Use the following tests in conjunction with the "Troubleshooting" in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe "Precautions", immediately preceding, to prevent damage to alternator system.

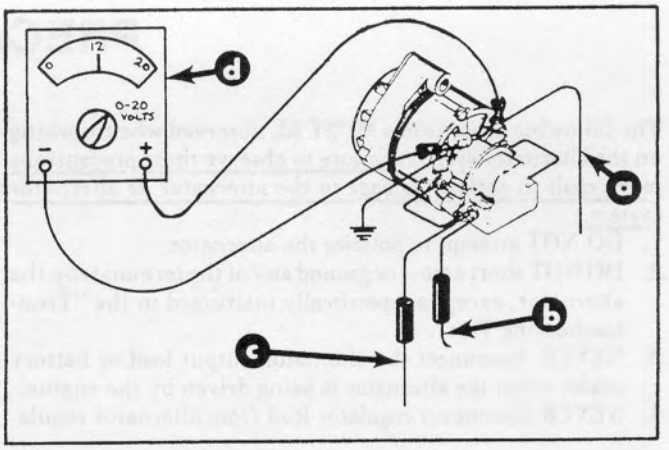
1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined in "Section 3 Part A". Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive belt tension and adjust if necessary, as outlined under "Drive Belt Tension Adjustment", preceeding in this section.

CIRCUITRY TEST

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

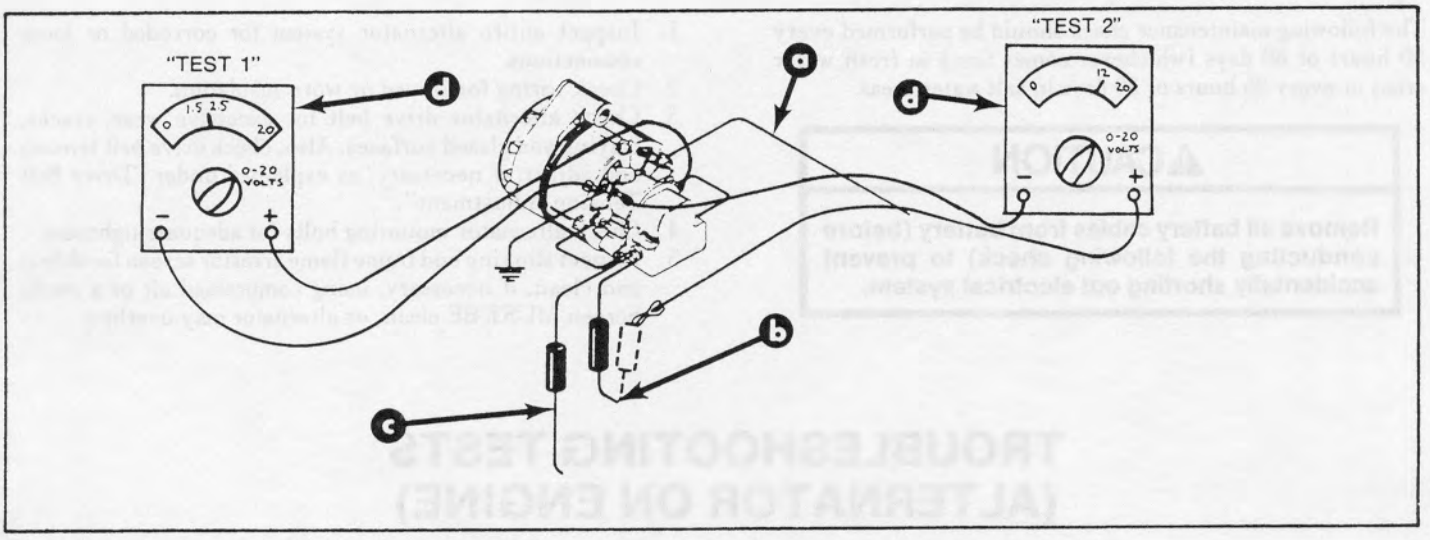
Output Circuit

1. Connect positive voltmeter lead to alternator output terminal and negative lead to a ground terminal on alternator. (Figure 1)
2. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximately battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or damaged wiring.



a - Output Wire - Orange (Red/White)
b - Excitation Wire - Purple (White)
c - Sensing Wire - Red/Purple (Red)
d - Volt Meter (0-20 Volts)

Figure 1. Alternator Output Circuit Test



a - Output Wire - Orange (Red/White)
b - Excitation Wire - Purple (White)
c - Sensing Wire - Red/Purple (Red)
d - Volt Meter (0-20 Volts)

Figure 2. Alternator Excitation Circuit Test

Excitation Circuit

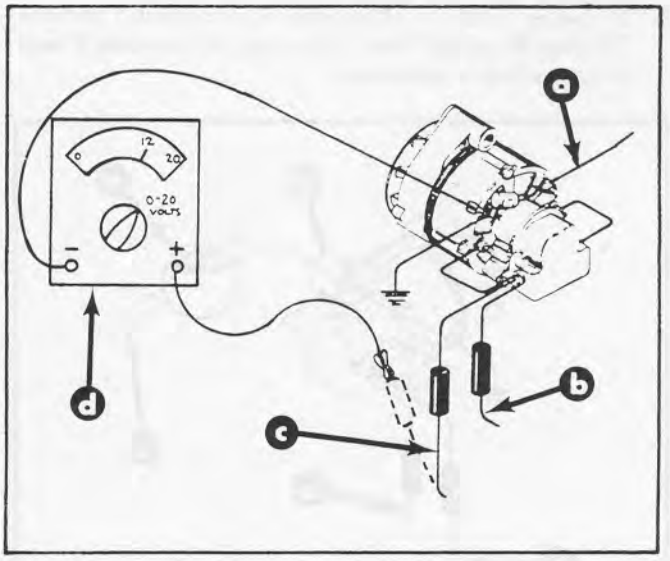
1. Connect positive (+) voltmeter lead to regulator terminal on alternator and negative (-) lead to a ground terminal on alternator. (Test No. 1 in Figure 2)
2. Turn ignition switch to "On" position and note voltmeter reading. Reading should be 1.5 to 2.5 volts.
3. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug purple (or white) lead from regulator. Connect positive voltmeter lead to purple (or white) lead and negative voltmeter lead to ground. (Test No. 2 in Figure 2) If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.
4. If reading is between .75 and 1.1 volts, rotor field circuit probably is shorted or grounded. Disassemble alternator and test rotor as outlined under "Alternator Repair", following.
5. If reading is between 6.0 and 7.0 volts, rotor field circuit probably is open. Remove regulator and inspect for worn brushes or dirty slip rings. Replace brushes if less than ¼" (6mm) long. If brushes and slip rings are in good condition, disassemble alterntor and test rotor, as outlined under "Alternator Repair".
6. If reading is between 8.5 and 10.0 volts, an open probably exists in load circuit of regulator. To be certain that this is the problem, remove 4 screws which secure the regulator to the alternator. Connect a jumper wire between regulator terminal and field (brush) terminal. (Figure 3) DO NOT allow jumper lead to touch alternator housing. Repeat test. If jumper wire provides correct voltmeter reading (1.5 to 2.5 volts), voltage regulator is faulty and must be replaced.

a - Jumper Wire Connected between Regulator Terminal and Field (Brush) Terminal
b - Use Insulators to Prevent Wire from Contacting Alternator

Figure 3. Checking for Faulty Regulator Load Circuit

Sensing Circuit

1. Unplug red/purple (or red) lead from voltage regulator.
2. Connect positive voltmeter lead to red/purple (or red) lead and negative voltmeter lead to ground terminal. (Figure 4)
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit [red/purple (or red) lead] for loose or dirty connections or damaged wiring.



a - Output Wire - Orange (Red/White)
b - Excitation Wire - Red/Purple (Red)
c - Sensing Wire - Purple (White)
d - Volt Meter (0-20 Volts)

Figure 4. Regulator Sensing Circuit Test

CURRENT OUTPUT TEST

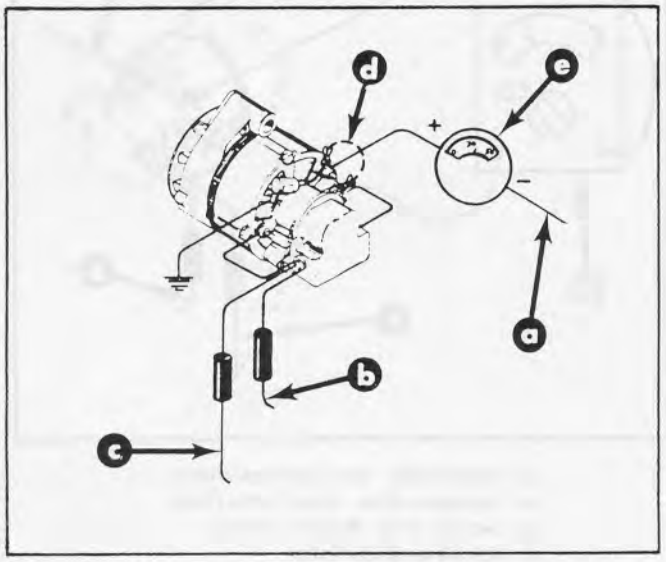
Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (-) battery cable from battery.
2. Disconnect orange (or red/white) lead from alternator output terminal and connect ammeter in series between lead and output terminal. (Figure 7) Connect positive (+) side of ammeter toward output terminal.
3. Reconnect negative battery cable.
4. Remove coil hi-tension lead from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.

5. Turn off accessories and reinstall coil hi-tension lead. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper wire between alternator output terminal and regulator terminal. (Figure 5) Repeat Steps 4 and 5.
7. If reading is now within specifications, diode trio is faulty. Disassemble alternator and replace diode trio, as explained under "Alternator Repair", following.
8. If reading is still low with jumper wire connected, perform "Voltage Regulator Test", following, to determine if fault is in regulator or alternator.



a - Output Wire - Orange (Red/White)
b - Excitation Wire - Purple (White)
c - Sensing Wire - Red/Purple (Red)
d - Jumper Wire For Testing Diode Trio
e - Ammeter (0-50 Amps)

Figure 5. Alternator Current Output Test

VOLTAGE OUTPUT TEST

Perform this test to determine if voltage regulator is operating correctly, using a 0-20 volt DC volmeter.

IMPORTANT: Battery MUST BE fully charged (1.260 or above specific gravity) to obtain proper voltage reading in this test. If necessary, charge battery with a battery charger or allow engine to run a sufficient length of time to fully charge battery before taking reading.

1. Connect positive (+) voltmeter lead to positive battery terminal and negative (–) voltmeter lead to negative terminal. (Figure 6)
2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7 volts.
3. If reading is high, check for a loose or dirty regulator ground lead connection. If connection is good (and sensing circuit checked out good in "Alternator System Circuitry Test"), voltage regulator is faulty and must be replaced. Be sure to disconnect battery cables before attempting to remove regulator.

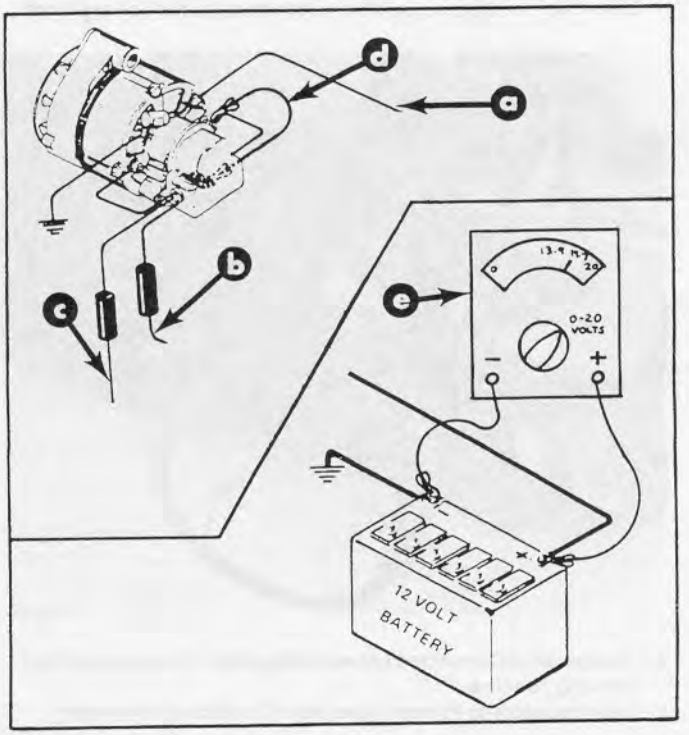
⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the next steps) to prevent the possibility of an explosion and/or fire, should a spark occur.

⚠CAUTION

DO NOT allow jumper wire to contact alternator end frame (in next step), as diode trio and regulator may be damaged.

4. If reading is low, stop engine and remove 4 regulator attaching screws. Pull regulator away from alternator end frame to gain access to field terminal. DO NOT disconnect regulator leads. Connect a jumper wire between field (brush) terminal and regulator terminal. (Figures 5 and 8) Restart engine and gradually increase engine speed to 1500 RPM while observing voltmeter. DO NOT allow voltage to exceed 16 volts.
5. If a voltmeter reading of 14.5 volts or above is now obtained, voltage regulator is faulty and must be replaced. If voltmeter reading is below 14.5 volts, inspect brushes and slip rings for wear, dirt or damage. If brushes and slip rings are good, alternator is faulty internally. Disassemble alternator and test components, as outlined under "Alternator Repair", following.



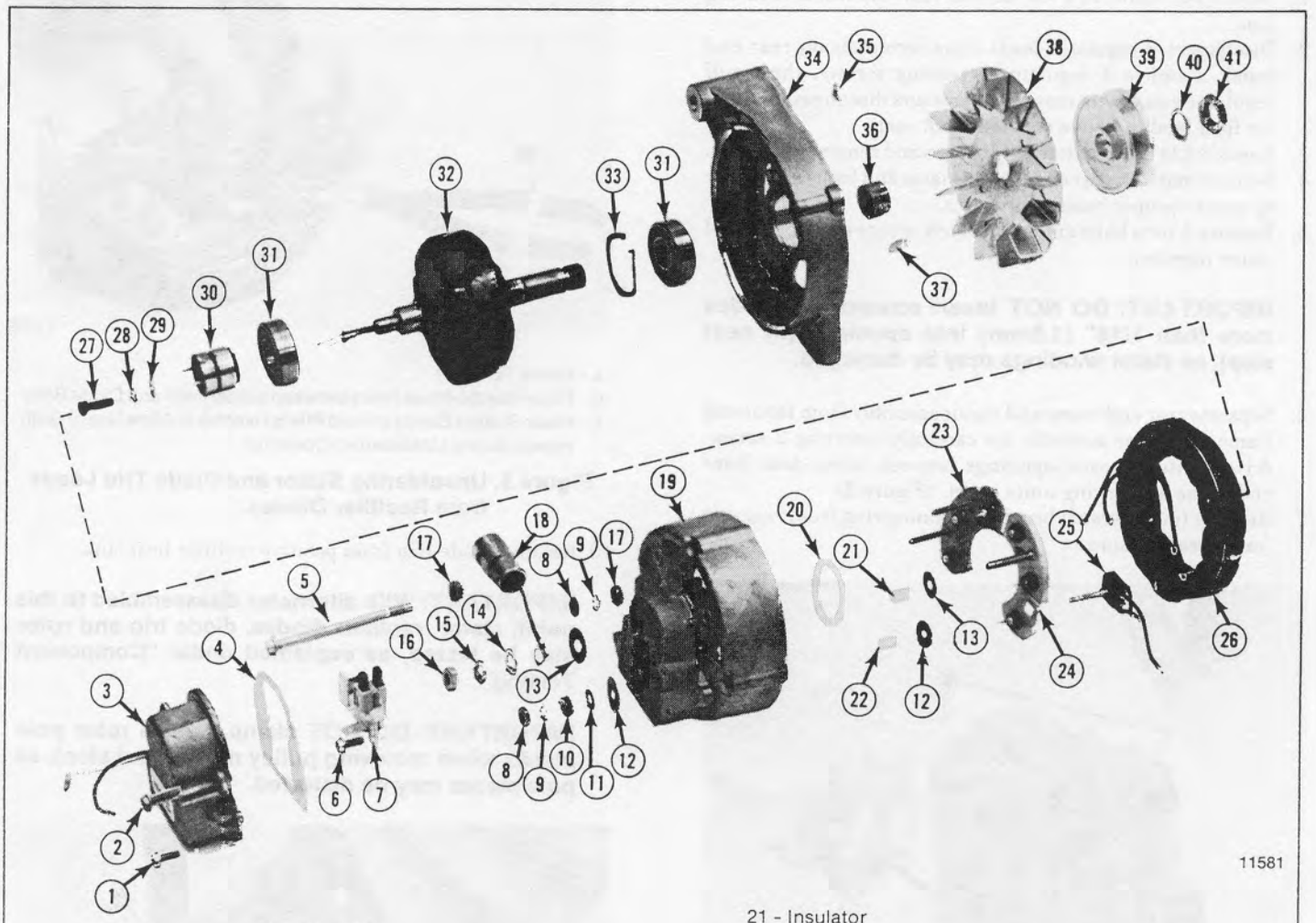
a - Output Wire - Orange (Red/White)
b - Excitation Wire - Purple (White)
c - Sensing Wire - Red/Purple (Red)
d - Jumper Wire To Eliminate Regulator
e - Volt Meter (0-20 Volts)

Figure 6. Voltage Regulator Test

ALTERNATOR REPAIR

REMOVAL

1. Disconnect negative (-) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator brace to alternator attaching bolt, washer(s) and spacer (if used).
4. Loosen alternator brace to engine attaching bolt and alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washers (if used), spacer and nut and remove alternator.



1 - Screw (2)
2 - Screw (2)
3 - Regulator
4 - Felt Seal
5 - Bolt (4)
6 - Screw (2)
7 - Brush Set
8 - Nut (2)
9 - Lockwasher (2)
10 - Nut (Self-Locking)
11 - Flat Washer
12 - Insulating Washer (2)
13 - Insulating Washer (2)
14 - Flat Washer
15 - Lockwasher
16 - Nut
17 - Nut (Self-Locking) (2)
18 - Condenser
19 - End Frame
20 - Bearing Retainer
21 - Insulator
22 - Insulator
23 - Negative Rectifier Diode Set
24 - Positive Rectifier Diode Set
25 - Diode Trio
26 - Stator
27 - Screw
28 - Lockwasher
29 - Flat Washer
30 - Slip Ring
31 - Bearing (2)
32 - Rotor
33 - Bearing Retaining Ring
34 - End Frame
35 - Nut (4)
36 - Spacer
37 - Key
38 - Fan (Bi-Rotational Shown)
39 - Pulley
40 - Lockwasher
41 - Nut

Figure 1. Motorola Alternator Parts View

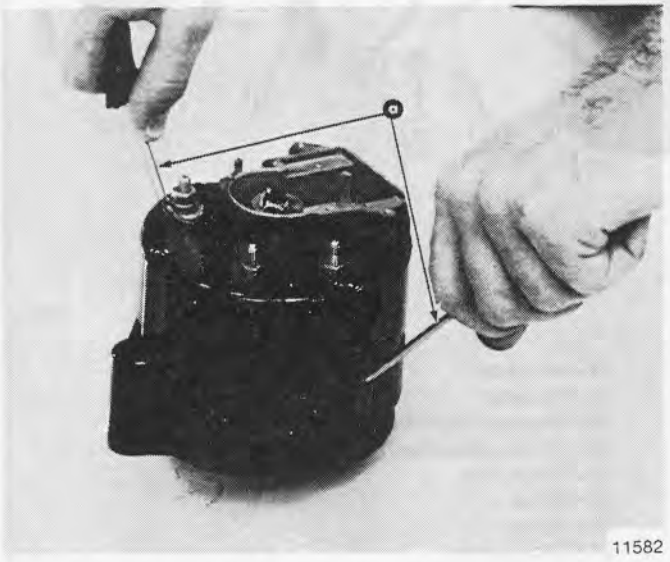
DISASSEMBLY

IMPORTANT: The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

1. Mount alternator in a vise so that rear end frame is facing you.
2. Disconnect 2 regulator leads from terminals on rear end frame. Remove 4 regulator attaching screws, then pull regulator away from rear end frame and disconnect regulator field lead. Remove regulator felt seal.
3. Remove 2 brush set attaching screws and remove brush set.
4. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.
5. Remove 4 thru bolts and nuts which secure end frames and stator together.

IMPORTANT: DO NOT insert screwdriver blades more than 1/16" (1.6mm) into openings (in next step), as stator windings may be damaged.

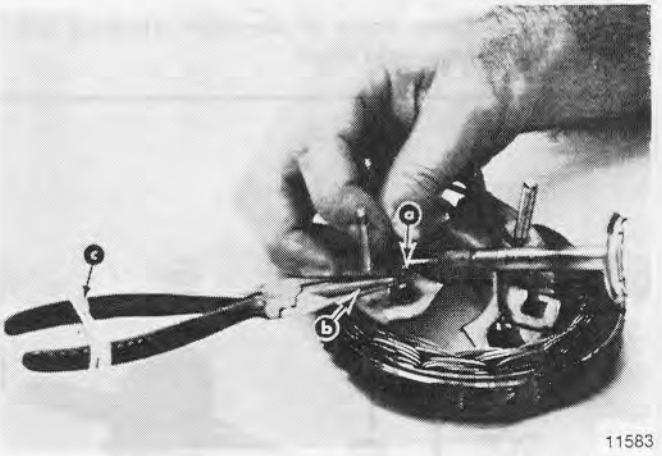
6. Separate rear end frame and stator assembly from front end frame and rotor assembly by carefully inserting 2 screwdrivers into opposite openings between stator and front end frame and prying units apart. (Figure 2)
7. Remove (and discard) bearing retaining ring from rear end frame bearing bore.



a - DO NOT Insert Screwdriver Blades More Than 1/16" into Openings

Figure 2. Separating Rear End Frame and Stator Assembly from Front End Frame and Rotor Assembly

8. Place rear end frame and stator assembly on the bench with stator downward. Be sure that bench is clean and free of metal chips. Remove nuts, washers, insulators and condenser from rectifier mounting studs and lift rear end frame from studs. Remove 2 insulating sleeves and washers from rectifier studs.
9. Unsolder stator and diode trio leads from rectifier diode terminals. Place a needle-nose pliers on diode terminal between solder joint and diode body (as shown in Figure 3) to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



a - Diode Terminal
b - Place Needle-Nose Pliers between Solder Joint and Diode Body
c - Place Rubber Bands around Pliers Handles to Allow Use of Both Hands during Unsoldering Operation

Figure 3. Unsoldering Stator and Diode Trio Leads from Rectifier Diodes

10. Remove diode trio from positive rectifier heat sink.

IMPORTANT: With alternator disassembled to this point, stator, rectifier diodes, diode trio and rotor may be tested, as explained under "Component Testing".

IMPORTANT: DO NOT clamp vise on rotor pole pieces when removing pulley nut (in next step), as pole pieces may be distorted.

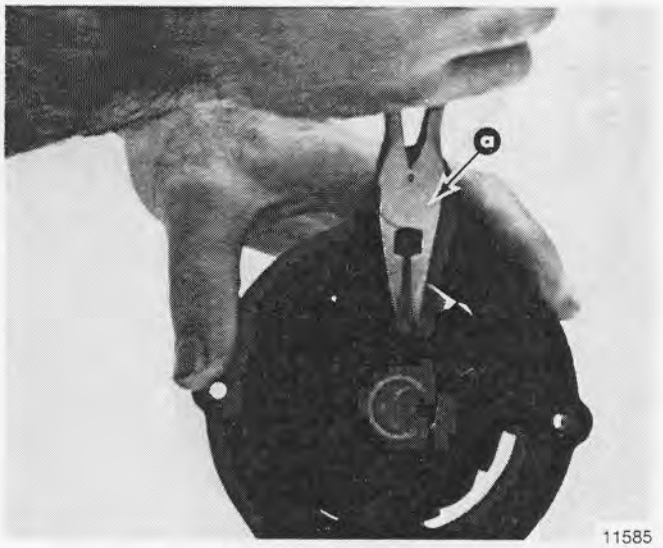
a - Wrench
b - Use Oversize V-Belt to Protect Pulley

Figure 4. Removing Pulley Nut

11. Remove pulley retaining nut by clamping pulley in a vise (using an old oversize V-belt or protective jaws to protect pulley) and turning nut counterclockwise with a wrench. (Figure 4) Remove lockwasher and slide pulley and fan from shaft. If pulley is "stubborn", it may be necessary to use an universal pullers.
12. Remove key from rotor shaft with a diagonal pliers, then slide fan spacer from shaft.

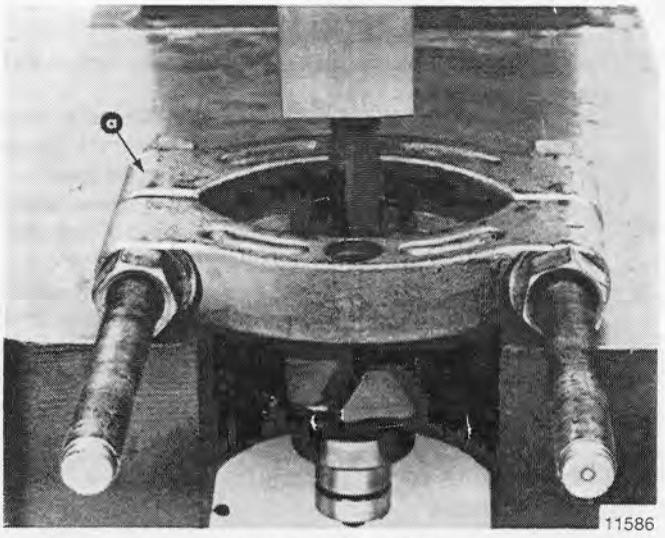
IMPORTANT: DO NOT remove front end frame from rotor shaft, unless absolutely necessary, as front bearing MUST BE replaced, if it is removed.

13. Using a long-nose pliers, compress ears of front bearing retainer and lift retainer free of recess in front end frame. (Figure 5) Tap pulley end of rotor shaft with a rawhide mallet to remove rotor and front bearing assembly from front end frame.
14. Remove front bearing from rotor shaft with Universal Puller Plate and an arbor press, as shown in Figure 6. (Discard bearing.)



a - Compress Ears of Retainer and Lift

Figure 5. Removing Front Bearing Retainer from Recess



a - Universal Puller Plate

Figure 6. Removing Front Bearing from Rotor Shaft

15. If rotor slip rings or rear bearing require replacement, carefully unsolder rotor field winding leads from slip ring terminals and unwind end of leads. Remove slip ring attaching screw, lockwasher and flat washer and slide slip rings from shaft.
16. If rear bearing requires replacement, remove bearing from rotor shaft with Universal Puller Plate and arbor press. Bearing MUST BE replaced, if removed.

CLEANING and INSPECTION

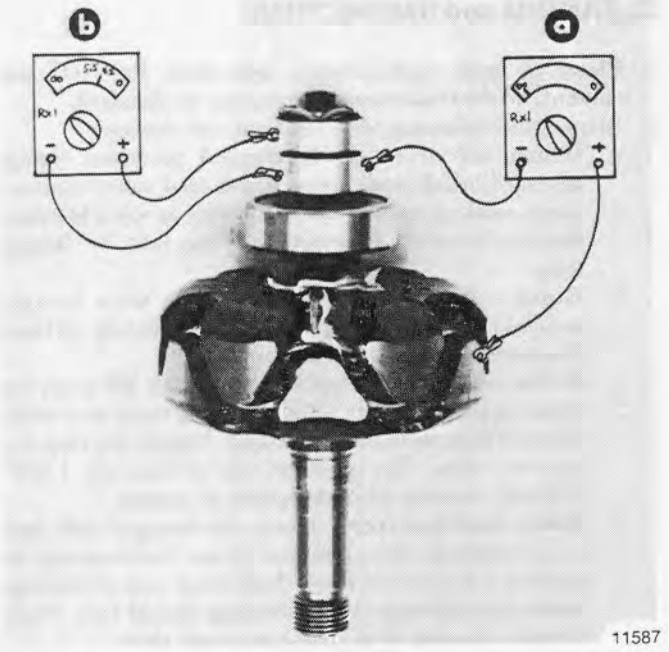
1. Clean all parts with a clean, soft cloth. DO NOT use solvent, or electrical components may be damaged.
2. Inspect the following parts for wear and damage:
   a. **Brush set** - inspect for cracked porcelain casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than ¼" (6mm) long.
   b. **Rotor** - inspect for stripped threads, worn keyway, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. **Rotor slip rings** - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-rounders [.002" (.05mm) maximum] and replace, if present.
   d. **Rotor shaft bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
   e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration; as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. **Regulator** - inspect leads for damaged insulation.
   g. **Front and rear end frames** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) MUST BE replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.
   h. **Fan** - inspect for cracked or bent fins, broken welds (bi-rotational fan only) or worn mounting hole (from fan spinning on shaft).
   i. **Pulley** - inspect pulley mounting bore and key groove for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, grooves, pits, nicks or corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair. Drive surfaces MUST BE perfectly true and smooth, or drive belt wear will be greatly accelerated.

COMPONENT TESTING

Rotor

1. Test rotor field circuit for grounds, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect one lead of ohmmeter to either slip ring and the lead to rotor shaft or pole pieces. (Figure 7)
   b. Meter should indicate no continuity (meter should not move).
   c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess

solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace rotor assembly. If continuity is eliminated, replace slip rings.



a - Test for Grounds
b - Test for Opens, Shorts or High Resistance

Figure 7. Testing Rotor Field Circuit

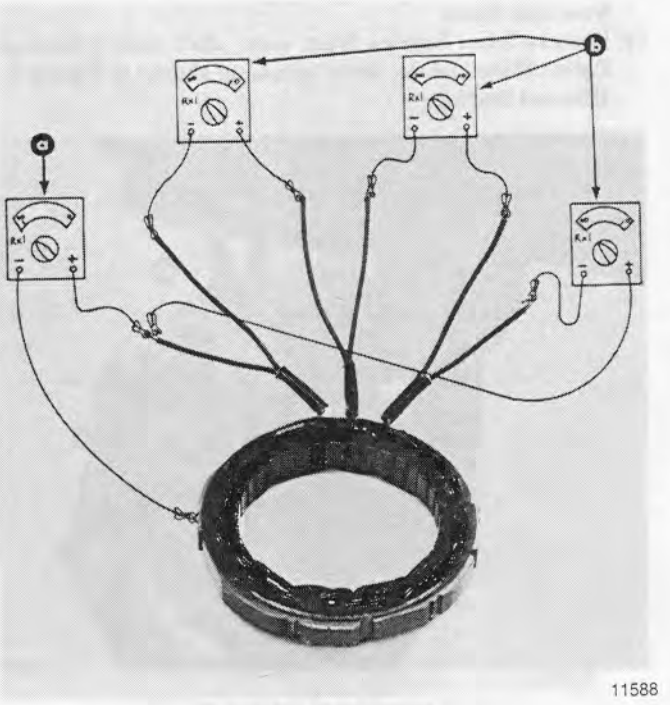
2. Test rotor field circuit for opens, shorts or high resistance, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect one ohmmeter lead to each slip ring. (Figure 7)
   b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperature [70° - 80° F (21° - 26° C)].
   c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor conncections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, replace slip rings. If reading is still high or infinite, replace complete rotor assembly.
   d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, slip rings are shorted and must be replaced. If reading is still low, rotor field windings are shorted, and complete rotor assembly must be replaced.

IMPORTANT: If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, because of centrifugal force. Replace rotor, if all other electrical components test good.

Stator

IMPORTANT: Stator leads MUST BE disconnected from rectifier diodes and diode trio for this test.

1. Test stator for grounds, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. (Figure 8) Be sure that lead makes good contact with frame.
   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.



a - Testing for Grounds
b - Testing for Opens

Figure 8. Testing Stator

2. Test for opens in stator, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect ohmmeter between each pair of stator windings (3 different ways). (Figure 8) Either of the 2 leads (coming from each stator windings) may be used.
   b. Continuity should be present in all 3 cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.
3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sure sign of a short.

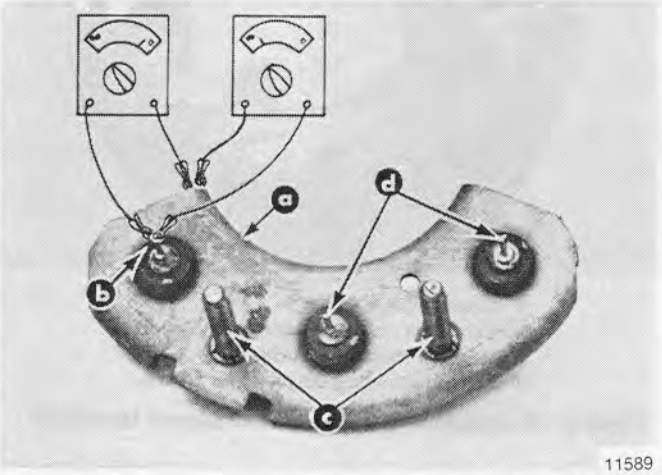
Rectifier Diodes

IMPORTANT: Rectifier diodes MUST BE disconnected from stator and diode trio for this test.

⚠CAUTION

DO NOT use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to rectifier diode heat sink and the other lead to one of the rectifier diode terminals. (Figure 9) Note the reading. DO NOT connect ohmmeter lead to mounting stud(s).
2. Reverse test leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink. Also, test other rectifier diode set in same manner.
5. Replace complete rectifier set, if any of the diodes are shorted or open.



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a - Heat Sink
b - Diode Terminal
c - Do Not Connect Lead to Studs
d - Test These 2 Diodes in Same Manner

Figure 9. Testing Rectifier Diodes for Shorts or Opens (Negative Rectifier Diode Set Shown)

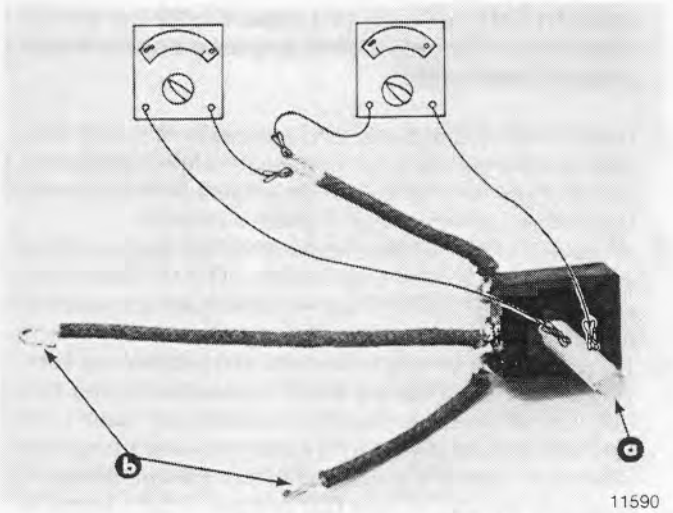
Diode Trio

IMPORTANT: Diode trio leads MUST BE disconnected from rectifier diodes and stator leads for this test.

⚠CAUTION

DO NOT use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to diode trio stud and the other lead to one of the diode trio leads. (Figure 10) Note ohmmeter reading.
2. Reverse ohmmeter leads and again note reading.
3. Meter should indicate a high or infinite reading (no meter movement) when meter is connected one way and a low reading when meter is connected the other way. If both readings are high, diode (in diode trio) is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 between diode trio stud and each of the other 2 leads.
5. Replace diode trio if any of the diodes are shorted or open.



11590

a - Stud
b - Repeat Test between These Leads and Stud

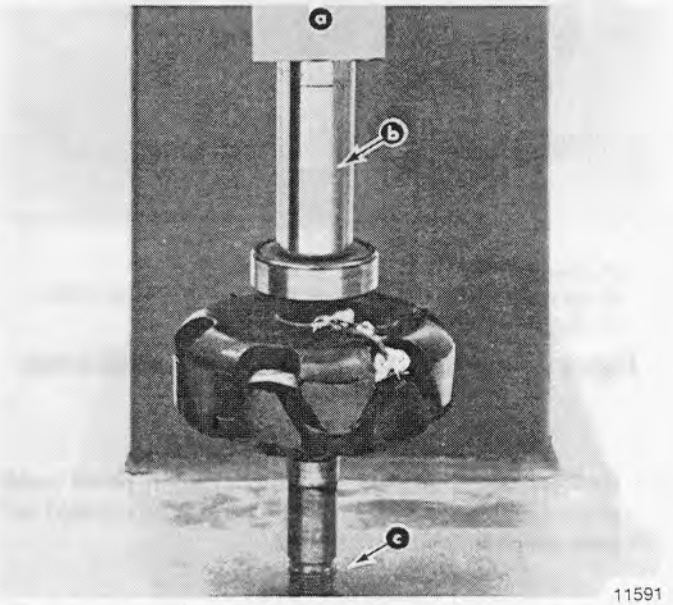
Figure 10. Testing Diode Trio for Shorts or Opens

Condenser

1. Using Magneto Analyzer and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd)
   b. Condenser Short or Leakage Test
   c. Condenser Series Resistance Test
2. Replace condenser, if test results are not within specifications.

REASSEMBLY

1. Press new rear bearing all-the-way onto rotor shaft (until inner race contacts shoulder) with an arbor press and a bearing driver that contacts inner bearing race only, as shown in Figure 11. Use extreme care to prevent damage to field winding leads.



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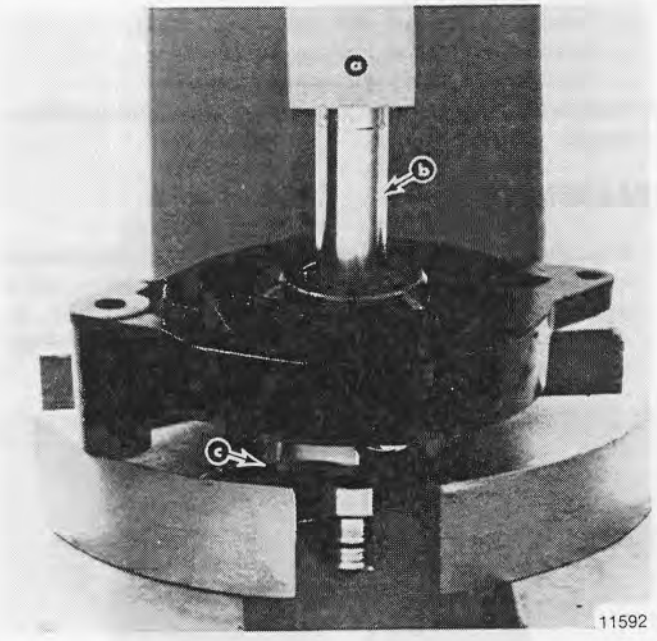
a - Arbor Press
b - Bearing Driver (Must Contact Inner Bearing Race Only)
c - Support Pulley End of Shaft on Arbor Press Base (DO NOT Support Rotor on Pole Pieces)

Figure 11. Installing Rear Bearing on Rotor Shaft

IMPORTANT: Be sure to support rotor on end of shaft and not on pole pieces, as pole pieces are only press-fit onto shaft.

2. Insert field winding leads thru passage in slip ring hub, then hand-press slip rings onto shaft while maintaining proper alignment with leads and passage. Install cap screw, lockwasher and flat washer. Tighten securely.
3. Wrap ends of field winding leads around slip ring terminals and solder with rosin core solder. DO NOT use excessive solder. Also, DO NOT use excessive heat, or insulation on field winding leads may be damaged.
4. Press new front bearing into front end frame bearing bore. If necessary, use a bearing driver that contacts outer race only. Install bearing retainer into recess in end frame (with ears outward and aligned with opening), using a long nose pliers and a punch. Use extreme care to prevent damage to front bearing seal. Be sure that retainer is fully seated in groove (ears should touch both sides of recess).
5. Press front end frame and bearing assembly onto rotor shaft (until inner bearing race contacts shoulder) with an arbor press and a bearing driver that fits over shaft and contacts inner bearing race only, as shown in Figure 12. Be sure to support rotor on pole pieces only.

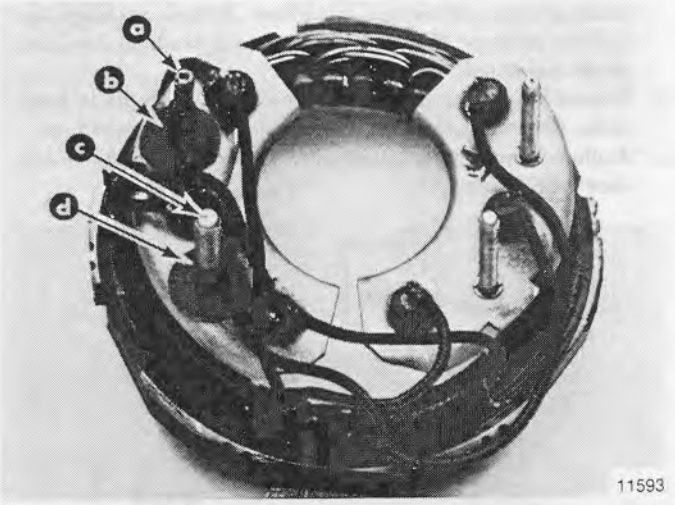


a - Arbor Press
b - Bearing Driver (Must Contact Inner Bearing Race Only)
c - Support Rotor on Pole Pieces

Figure 12. Installing Front End Frame and Bearing Assembly on Rotor Shaft

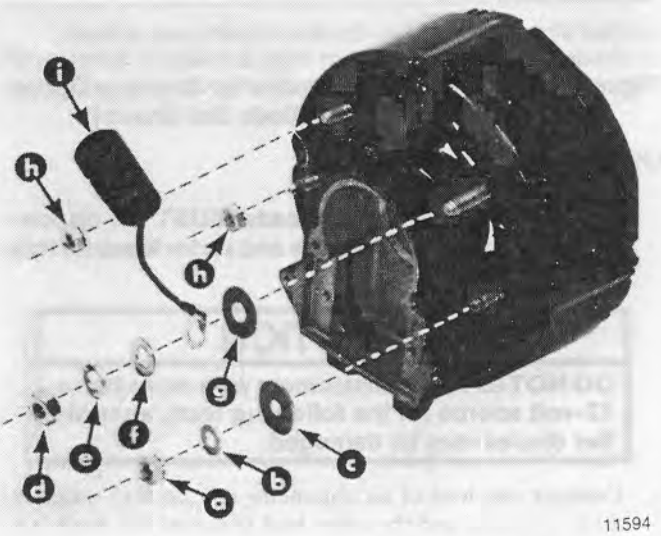
IMPORTANT: DO NOT clamp vise on rotor pole pieces when tightening pulley nut (in next step), or pole pieces may be distorted.

6. Slide fan spacer onto rotor shaft. Install new woodruff key, then install fan, pulley, lockwasher and nut on shaft. Clamp pulley in a vise, using protective jaws or an old over-size V-belt to protect pulley (Figure 4), and torque nut to specifications. Tighten vise only enough to allow tightening of nut, as excessive tightening may distort pulley.
7. Position diode trio in positive rectifier set heat sink. Using rosin core solder, resolder stator and diode trio leads to rectifier diodes, as shown in Figure 13. Use long-nose pliers to prevent heat damage to diodes. Solder connections as quickly as possible and allow them to cool before removing pliers.
8. Place insulating washers and sleeves on diode trio stud and positive rectifier set stud, as shown in Figure 13.
9. Guide rear end frame onto diode trio and rectifier diode set studs, then install condenser, insulating washers, flat washers, lockwashers and nuts, as shown in Figure 14. Tighten nuts securely.



a - Diode Trio Stud
b - Small Insulating Washer and Sleeve
c - Positive Rectifier Set Stud
d - Large Insulating Washer and Sleeve

Figure 13. Insulating Washer and Sleeve Installed

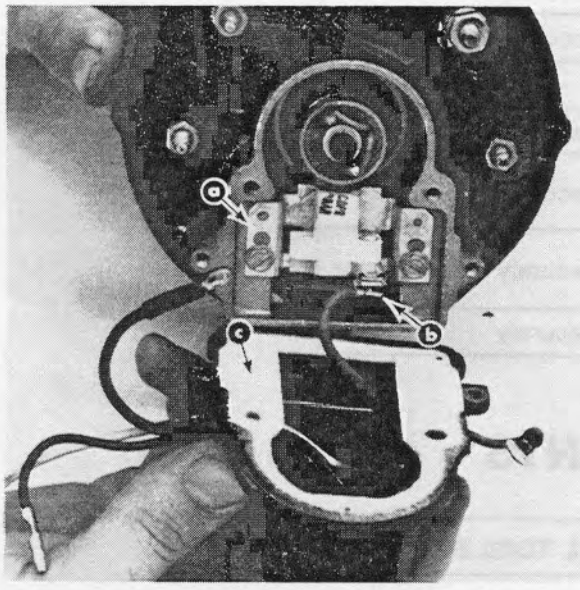


a - Self Locking Nut
b - Flat Washer
c - Insulating Washer
d - Nut
e - Lockwasher
f - Flat Washer
g - Insulating Washer
h - Self-Locking Nuts
i - Condenser

Figure 14. Attaching Rear End Frame to Rectifier Diode Sets and Diode Trio

10. Install new rear bearing retainer in recess in rear end frame bearing bore. Lubricate exposed surface of retainer with a small amount of hydraulic brake fluid to ease assembly over the rear bearing. DO NOT use oil or grease.
11. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install thru bolts and square nuts. Tighten bolts securely.
12. Place brush set in rear end frame cavity and secure with 2 mounting screws, as shown in Figure 15. Be sure to use outer-most mounting holes. Tighten securely.
13. Position felt seal on regulator mounting surface. Connect regulator field lead to brush terminal (shown in Figure 15), then mount regulator. Tighten securely.

IMPORTANT: Regulator field lead MUST BE connected as shown in Figure 15, or lead may be damaged by rotor slip rings during operation.



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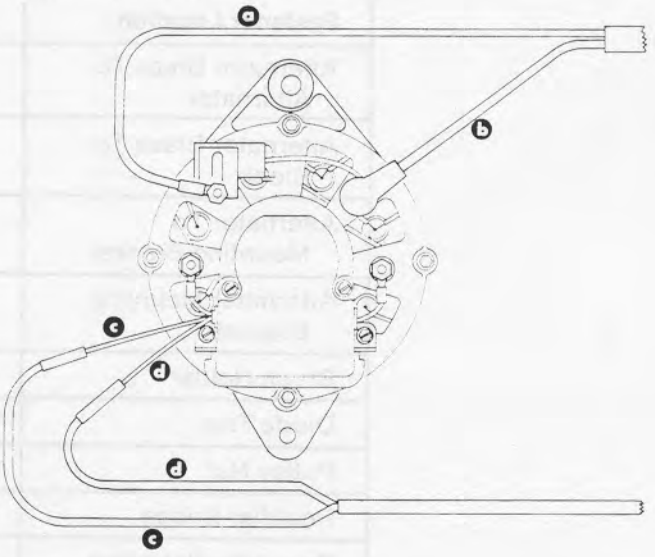
a - Brush Set (Use Outer Mounting Holes)
b - Be Sure to Connect Field Lead as Shown
c - Regulator Felt Seal

Figure 15. Installing Brush Set and Regulator

INSTALLATION

1. Position alternator in mounting bracket and install mounting bolt, washers (if used), spacer and nut. Place washers (if used) on each side of spacer. DO NOT tighten nut securely at this time.



a - Black
b - Orange (or Red/White)
c - Purple (or White)
d - Red/Purple (or Red)

Figure 16. Wiring Harness Connected to Alternator

2. Fasten alternator brace to alternator with bolt, washers and spacer (if used). DO NOT tighten bolt at this time.
3. Position alternator drive belt on pulleys and adjust tension as explained under "Drive Belt Tension Adjustment".
4. Reconnect wiring harness to alternator (Figure 16) and negative battery cable to battery.

DELCO ALTERNATOR

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace To Alternator		192 (28)
Alternator Brace To Block	30 (41)	
Alternator To Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
Brush Holder	Securely	
Diode Trio	Securely	
Pulley Nut	50 (68)	
Rectifier Bridge	Securely	
Regulator Retaining Screws	Securely	
Retainers (Flame Arrestor)	Securely	
Thru Bolts	Securely	

TOOLS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-31229A5	Bearing Removal and Installation Kit
91-76032	Magneto Analyzer
91-37241	Universal Puller Plate
91-99750	Volt/Ohmmeter

TOOLS PURCHASED LOCALLY
Ammeter (0-50 Amps)

SEALANTS	
92-25711	Quicksilver Liquid Neoprene

SPECIFICATIONS

Mercury Number (Delco Number)	Amp Output (Max.)	Rotation	No. of Wires
68085 (1102393)	37	Uni-Rotational	1 Wire
69729 (1102496)	37	Bi-Rotational	1 Wire
78477 (1102938 or 1102939)	37	Uni-Rotational	3 Wire
90793 (1103113)	37	Uni-Rotational	3 Wire
90794 (1103114)	37	Bi-Rotational	3 Wire

DESCRIPTION

Two basic types of Delco internally-regulated alternators are in use on MerCruiser Engines: The 1-wire alternator and the 3-wire alternator.

IMPORTANT: Reference to number of wires does not include ground wire.

Both the 1-wire and 3-wire alternators are very similar in construction and operation, with the exception of the voltage regulator. Each employs a rotor that is supported in 2 end frames by bearings and is driven by a pulley at approximately twice engine speed. The rotor contains a field winding that is encased between 2 multiple finger pole pieces. Both ends of the field winding are connected to 2 insulated slip rings that are mounted on the rotor shaft. Current is supplied to the field winding by 2 brushes (mounted in the slip ring end frame) which make continuous slipping contact with the slip rings. The current flow through the field winding creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end while the other ends are connected to a full-wave rectifier bridge. The rectifier bridge contains 6 diodes which are arranged in such a manner that it allows current to flow from ground, thru the stator and to the battery ("BAT") terminal, but not in the opposite direction. When current is supplied to the rotor field winding (source to be explained later), and the rotor is turned, the movement of the field induces an alternating current into the stator windings. The rectifier bridge then changes this current to direct current which appears at the battery ("BAT") terminal. A diode trio also is connected to the stator windings and to the rectifier bridge which supplies current to the rotor field winding during operation.

Voltage output of the alternator is maintained within prescribed limits for properly charging the battery by a transistorized voltage regulator that controls the flow of current thru the rotor field circuit. The regulator, which is used on the 1-wire alternator, senses internally within the alternator, while the regulator, that is used on the 3-wire alternator, is equipped with an external sensing circuit that senses near the battery. This external sensing feature allows the alternator to compensate for any resistance in the output circuit, thereby providing more accurate regulation of the voltage being applied to the battery. The voltage regulator, that is used on the 3-wire alternator, also is equipped with an excitation circuit which is connected to the ignition switch. It provides a small amount of current to the rotor field winding to initiate alternator output when starting. This enables the 3-wire alternator to build up voltage faster than the 1-wire alternator which relies solely on residual magnetism for initial start-up. Once the alternator is producing output, current for the rotor field winding is supplied solely by the diode trio. A diode (located in the regulator terminal connector) prevents current from the diode trio from feeding back thru the excitation circuit and into the ignition system, thus preventing engine run-on after the ignition switch is turned off.

Both alternators also are equipped with a fan (mounted on the rotor shaft) which induces air flow thru the alternator to remove the heat created by the rectifier bridge and stator. A capacitor is also utilized to protect the rectifier from high voltages and to suppress radio noise.

Current output of the alternator does not require regulation (as does the DC generator), as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within prescribed limits, the alternator cannot produce excessive current. A cutout relay in the alternator system also is not required as the rectifier diodes prevent the battery from discharging back through the stator.

The alternator system, that is used with the 1-wire and 3-wire alternators, include the alternator, battery and the wiring which connects these components. The 3-wire alternator system, in addition to these components, also includes the ignition switch and related wiring. Refer to "Section 3, Part F" for wiring diagram.

PRECAUTIONS

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious bodily injury and/or damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in "Troubleshooting Tests".
3. NEVER disconnect the alternator output lead or battery cables when the alternator is producing a charge. Make sure that all connections in the system are tight before starting the engine.
4. Before disconnecting battery cables (or other leads in alternator system), be sure that engine compartment is well ventilated and that there are no gasoline vapors present to prevent the possibility of an explosion and/or a fire should a spark occur. If boat is equipped with a bilge blower, run blower for at least 5 minutes before disconnecting cables.
5. Always disconnect both battery cables from battery before disconnecting any leads from alternator or other components in alternator system.
6. When installing battery, BE SURE to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and the positive (+) battery cable to positive (+) battery terminal. If cables are reversed, damage to voltage regulator and/or alternator diodes will result.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive, negative to negative).
8. When applying a booster charge to battery, be sure to disconnect both battery cables from battery to prevent alternator diodes and transistorized voltage regulator from being damaged.

PERIODIC MAINTENANCE

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connections.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under "Drive Belt Tension Adjustment"
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.

TROUBLESHOOTING TESTS (ALTERNATOR ON ENGINE)

Use the following tests in conjunction with the "Troubleshooting" in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe "Precautions", immediately preceding, to prevent damage to alternator system.

1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined in "Section 3, Part A". Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests.
3. Check battery cable connections and all other accessible alternator system electrical connections for looseness or corrosion.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive tension and adjust, if necessary, as outlined under "Drive Belt Tension Adjustment".

VOLTAGE REGULATION TEST

Perform this test to determine if alternator voltage output is being maintained within prescribed limits for properly charging the battery.

1. Connect positive (+) lead of a DC voltmeter (set on 0-20 volt scale) to positive (+) battery terminal and negative (-) lead to negative (-) terminal. (Figure 1)

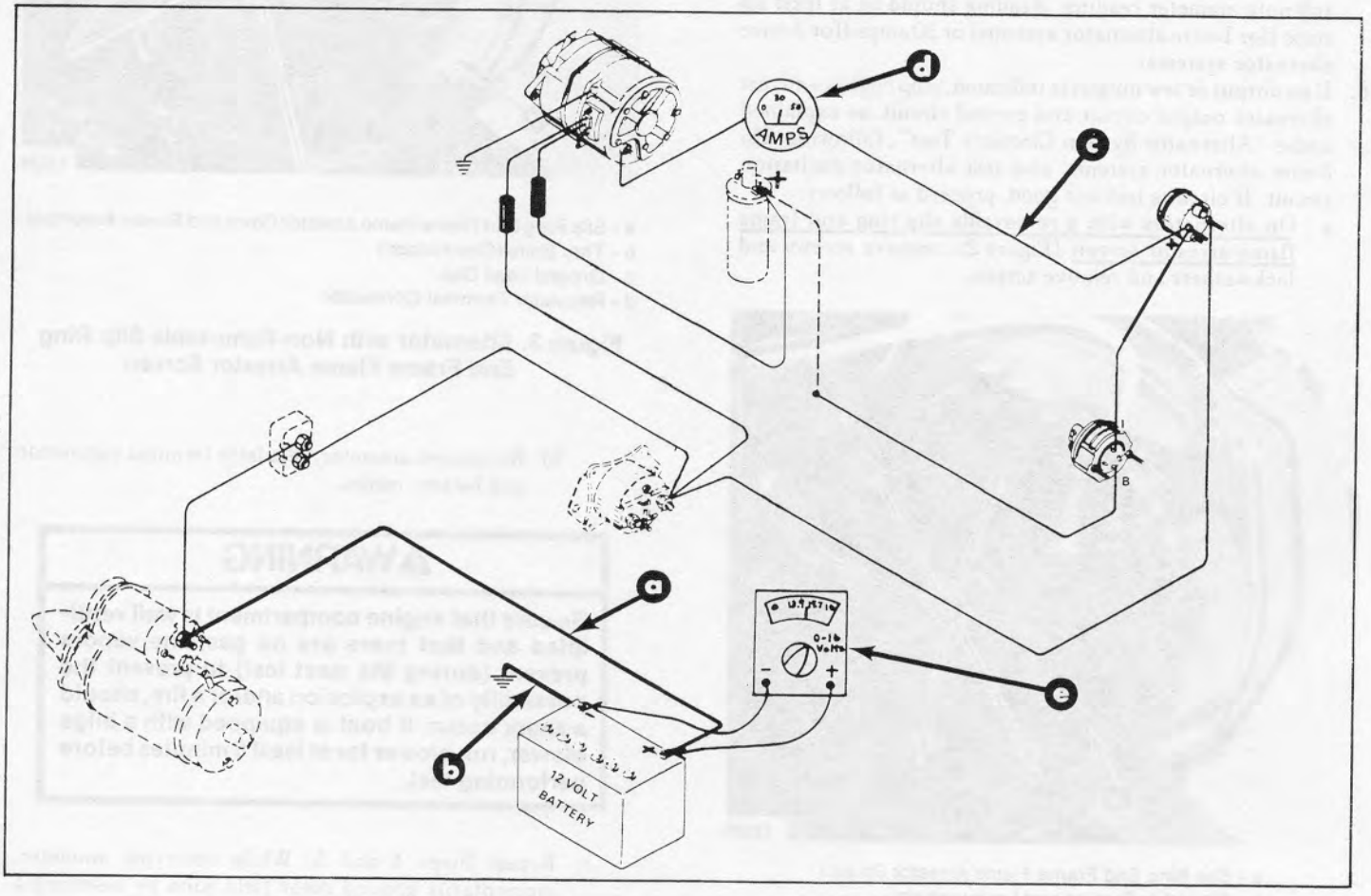
IMPORTANT: Battery MUST BE fully charged (1.260 specific gravity or above) to obtain proper voltage reading in next step. If necessary, charge battery with a battery charger or allow engine to run a sufficient length of time to fully charge battery before taking reading. All accessories MUST BE turned off during this test.

2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7.

IMPORTANT:On 3-wire alternator system only: If reading is normal, but frequent replacement of light bulbs at dash is necessary (indicating high voltage in alternator system), test alternator output circuit for excessive resistance, as explained under "Alternator System Circuitry Test", following.

3. If reading is low, stop engine and perform "Alternator Current Output Test", following, to locate source of problem.

4. If reading is high, stop engine and proceed as follows:
   a. On 3-wire alternator system only: Test alternator system sensing circuit, as explained under "Alternator System Circuitry Test", following.
   b. Remove alternator, disassemble and test the following components, as explained under "Alternator Repair".
      1) Test upper brush lead clip and voltage regulator for a grounded condition. If grounded, check for a missing or damaged insulator on upper brush lead clip insulated screw. If insulator is good, replace voltage regulator.
      2) Test rotor for a shorted field winding. If shorted, replace both rotor and regulator.
   c. If cause for overcharging condition cannot be found, replace voltage regulator.
   d. Reassemble alternator and reinstall as outlined under "Alternator Repair".



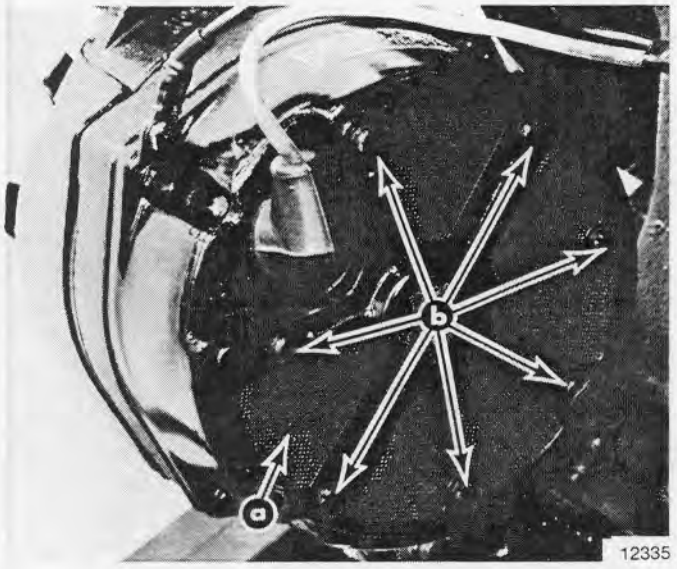
a - Red Battery Cable
b - Ground Cable
c - Output Wire - Orange (Red/White)
d - Ammeter (50 Amp Scale)
e - Voltmeter (0-20 Volts)

Figure 1. Alternator Voltage Regulator Test and Current Output Test

CURRENT OUTPUT TEST

Perform this test to determine if alternator is capable of producing rated current output.

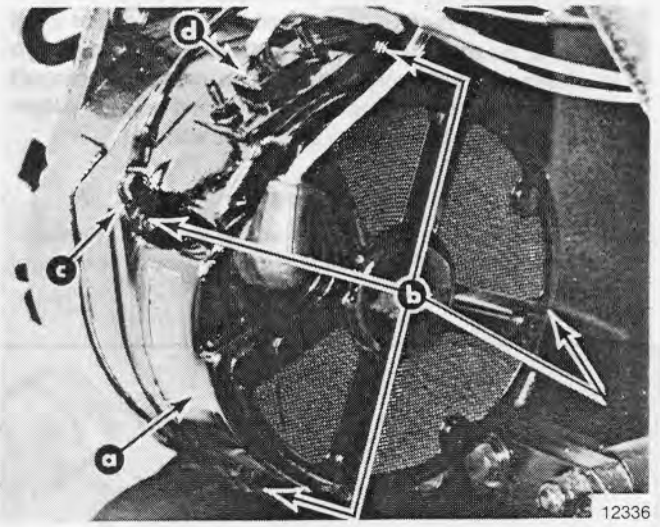
1. Disconnect battery cables from battery.
2. Disconnect orange (red-white) engine wiring harness lead from alternator battery ("BAT") terminal and connect a DC ammeter (with 0-50 amp scale) in series between lead and battery terminal. (Figure 1) Connect positive (+) side of ammeter toward battery terminal.
3. Reconnect battery cables.
4. Remove coil hi-tension lead from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.
5. Turn off accessories and reinstall coil hi-tension lead. Start engine and quickly adjust engine speed to 1500-2000 RPM and note ammeter reading. Reading should be at least 25 amps (for 1-wire alternator systems) or 30 amps (for 3-wire alternator systems).
6. If no output or low output is indicated, stop engine and test alternator output circuit and ground circuit, as explained under "Alternator System Circuitry Test", following. On 3-wire alternator systems, also test alternator excitation circuit. If circuits test out good, proceed as follows:
   a On alternators with a removable slip ring end frame flame arrestor screen (Figure 2), remove screws and lockwashers and remove screen.



a - Slip Ring End Frame Flame Arrestor Screen
b - Attaching Screws and Lockwashers

Figure 2. Alternator with Removable Slip Ring End Frame Flame Arrestor Screen

   b. On alternators with non-removable slip ring end frame flame arrestor screen (Figure 3), remove slip ring end frame flame arrestor cover and screen assembly, as follows:
      1) Disconnect battery cables from battery.
      2) Disconnect test ammeter from battery ("BAT") terminal on alternator.
      3) On 3-wire alternators only, remove nuts and bracket which secure regulator terminal connector (Figure 3) to alternator and remove connector.
      4) Remove 4 alternator thru bolts and ground lead clip (Figure 3), then, while holding slip ring end frame in position, remove slip ring end frame flame arrestor cover and screen assembly. Reinstall thru bolts and ground lead clip. Tighten screws securely.



a - Slip Ring End Frame Flame Arrestor Cover and Screen Assembly
b - Thru Bolts (One Hidden)
c - Ground Lead Clip
d - Regulator Terminal Connector

Figure 3. Alternator with Non-Removable Slip Ring End Frame Flame Arrestor Screen

      5) Reconnect ammeter, regulator terminal connector and battery cables.

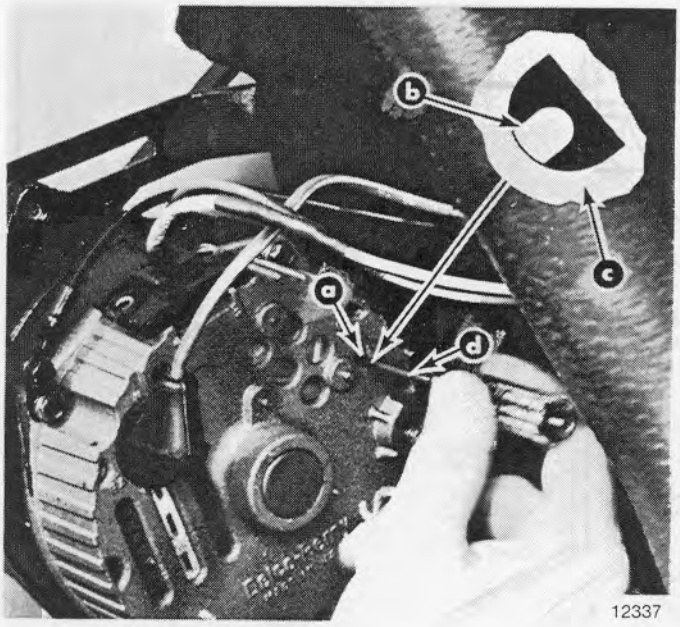
⚠WARNING

Be sure that engine compartment is well ventilated and that there are no gasoline vapors present (during the next test) to prevent the possibility of an explosion and/or a fire, should a spark occur. If boat is equipped with a bilge blower, run blower for at least 5 minutes before performing test.

   c. Repeat Steps 4 and 5. While observing ammeter, momentarily ground rotor field wind by inserting a screwdriver into test hole (Figure 4) and grounding tab to slip ring end frame.

⚠CAUTION

Tab is within ¾" (19mm) of slip ring end frame surface. DO NOT insert screwdriver deeper than 1" (25mm) into end frame, or damage to rotor may result.



a - Test Hole
b - Tab
c - Slip Ring End Frame
d - Ground Tab to End Frame with Screwdriver

Figure 4. Grounding Rotor Field Winding

d. If proper output is now obtained, remove alternator, disassemble and replace voltage regulator, as explained under "Alternator Repair", following.
e. If output is still low, remove alternator, disassemble and test rotor, stator, diode trio and rectifier bridge, as explained under "Alternator Repair", following.
f. Reassemble alternator and reinstall as outlined under "Alternator Repair".

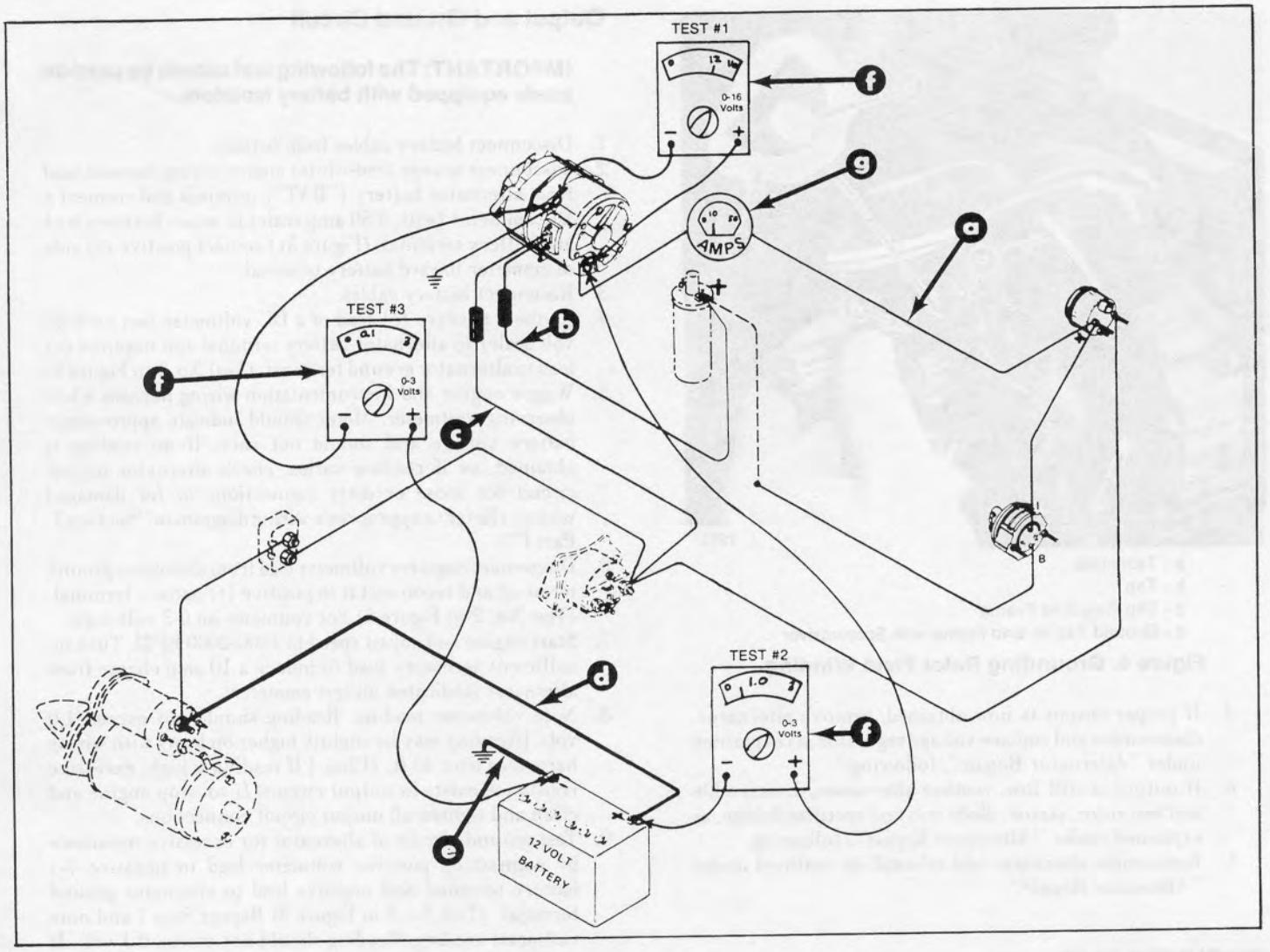
CIRCUITRY TEST

Perform the following test to determine if all of the circuits between the alternator and the other components within the system are in good condition.

Output and Ground Circuit

IMPORTANT: The following test cannot be used on boats equipped with battery isolators.

1. Disconnect battery cables from battery.
2. Disconnect orange (red-white) engine wiring harness lead from alternator battery ("BAT") terminal and connect a DC ammeter (with 0-50 amp scale) in series between lead and battery terminal. (Figure 5) Connect positive (+) side of ammeter toward battery terminal.
3. Reconnect battery cables.
4. Connect positive (+) lead of a DC voltmeter (set on 0-20 volt scale) to alternator battery terminal and negative (-) lead to alternator ground terminal. (Test No. 1 in Figure 5)
5. Wiggle engine and instrumentation wiring harness while observing voltmeter. Meter should indicate approximate battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or for damaged wiring. (Refer to appropriate wiring diagram in "Section 3, Part F")
6. Disconnect negative voltmeter lead from alternator ground terminal and reconnect it to positive (+) battery terminal. (Test No. 2 in Figure 5) Set voltmeter on 0-3 volt scale.
7. Start engine and adjust speed to 1500-2000 RPM. Turn on sufficient accessory load to induce a 10 amp charge from alternator (indicated on test ammeter).
8. Note voltmeter reading. Reading should not exceed 1.0 volt. [Reading may be slightly higher on boats with wiring harnesses over 40 ft. (12m).] If reading is high, excessive resistance exists in output circuit. If so, stop engine and clean and tighten all output circuit connections.
9. Test ground circuit of alternator for excessive resistance by connecting positive voltmeter lead to negative (-) battery terminal and negative lead to alternator ground terminal. (Test No.3 in Figure 5) Repeat Step 7 and note voltmeter reading. Reading should not exceed 0.1 volt. If reading is high, STOP ENGINE and clean and tighten all ground circuit connections.
10. Disconnect battery cables, remove meters and reconnect orange (red-white) engine wiring harness lead. Then, as a last step, reconnect battery cables.

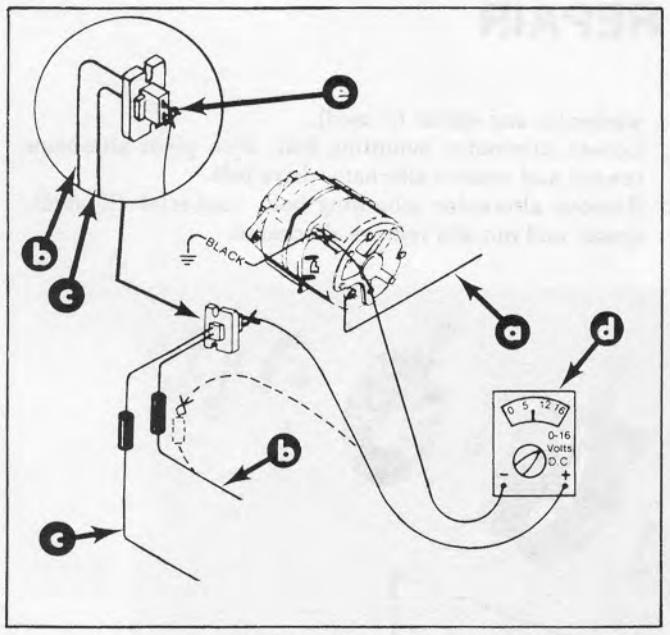


a - Output Wire - Orange (Red/White)
b - Excitation Wire - Purple (White)
c - Sensing Wire - Red/Purple (Red)
d - Red Battery Cable
e - Ground Cable
f - Voltmeter (0-20 Volts)
g - Ammeter (50 Amp Scale)

Figure 5. Alternator Output Circuit and Ground Test

Excitation Circuit (3-Wire Alternator Only)

1. Remove nuts and bracket, which secure regulator terminal connector (Figure 3) to alternator, and remove connector.
2. Using a pin or similar device, connect positive (+) lead of a DC voltmeter (set on 0-20 volt scale) to terminal in connector to which purple (white) wire is attached. Connect negative (-) voltmeter lead to alternator ground terminal. (Figure 12)
3. Turn ignition switch to "On" position.
4. Wiggle portion of engine wiring harness, that contains purple (white) excitation lead, while observing voltmeter. Meter should indicate at least 5 volts and should not vary.
5. If no reading is obtained, or if reading varies, turn ignition switch to "Off" and disconnect purple (white) engine wiring harness lead from regulator terminal connector at bullet connector.
6. Disconnect positive (+) voltmeter lead from regulator terminal connector and reconnect to purple (white) engine wiring harness lead (excitation lead). (Figure 6)



a - Output Wire - Orange (Red/White)
b - Excitation Wire - Purple (White)
c - Sensing Wire Red/Purple (Red)
d - Voltmeter (0-20 Volts)
e - Test Lead and Pin

Figure 6. Alternator Excitation Circuit Test

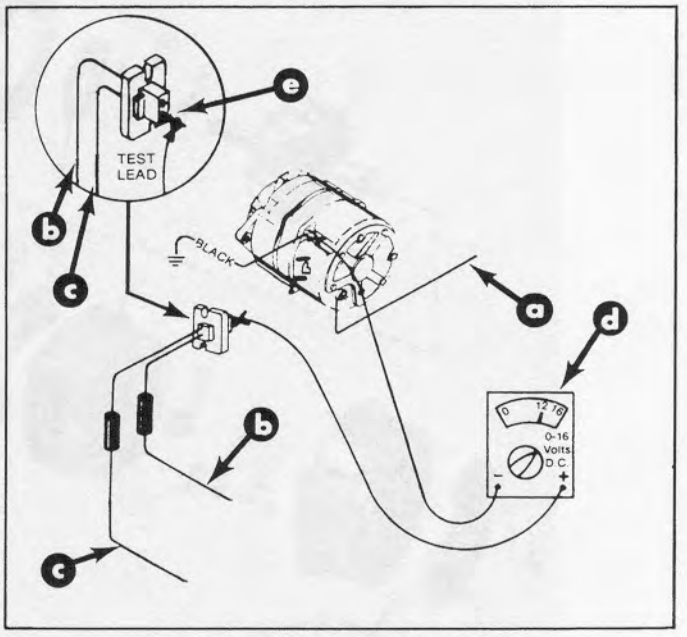
⚠CAUTION

DO NOT allow end of purple (white) engine wiring harness lead to contact engine (in next step), or an electrical short will occur.

7. Repeat Steps 3 and 4. If proper reading is now obtained, replace regulator terminal connector. If no reading is obtained, or if reading varies, check purple (white) engine wiring harness lead for loose or dirty connections or damaged wiring.
8. Reinstall regulator terminal connector. Be sure to insulate bullet connection(s) with heat shrink tubing or at least 4 layers of electrical tape.

Sensing Circuit (3-Wire Alternator Only)

1. Remove nuts and bracket, which secure regulator terminal connector (Figure 3) to alternator, and remove connector.
2. Using a pin or similar device, connect positive (+) lead of a DC voltmeter (set on 0-20 volt scale) to terminal in connector to which red/purple (red) lead is attached. Connect negative voltmeter lead to alternator ground terminal. (Figure 7)
3. With ignition switch in the "Off" position, wiggle portion of engine wiring harness, that contains red/purple (red) sensing lead, while observing voltmeter. Voltmeter should indicate battery voltage and should not vary. If no reading is obtained, or if reading varies, check red/purple (red) sensing lead for loose or dirty connections or damaged wiring.
4. Remove meter and reinstall regulator terminal connector.



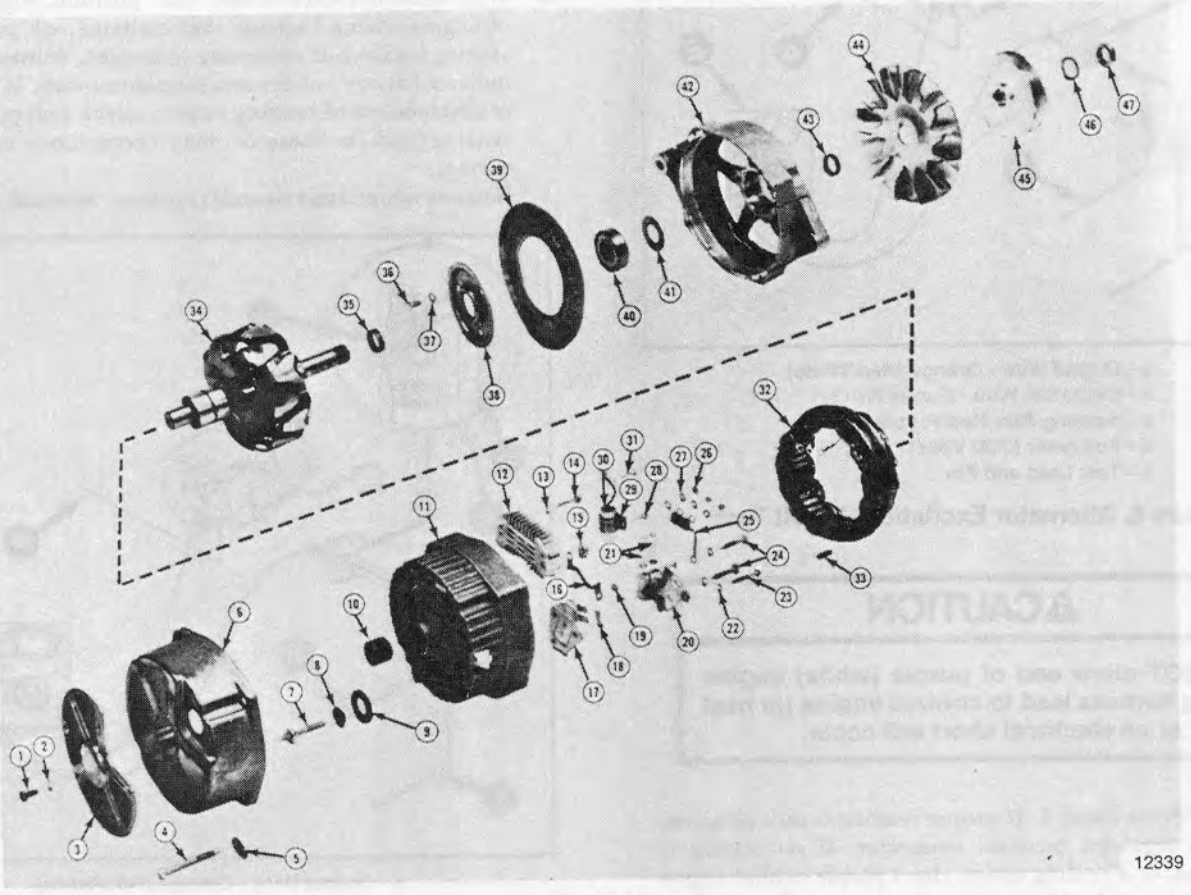
a - Output Wire - Orange (Red/White)
b - Excitation Wire - Purple (White)
c - Sensing Wire - Red/Purple (Red)
d - Voltmeter (0-20 Volts)
e - Pin and Test Lead

Figure 7. Alternator Sensing Circuit Test

ATERNATOR REPAIR

REMOVAL

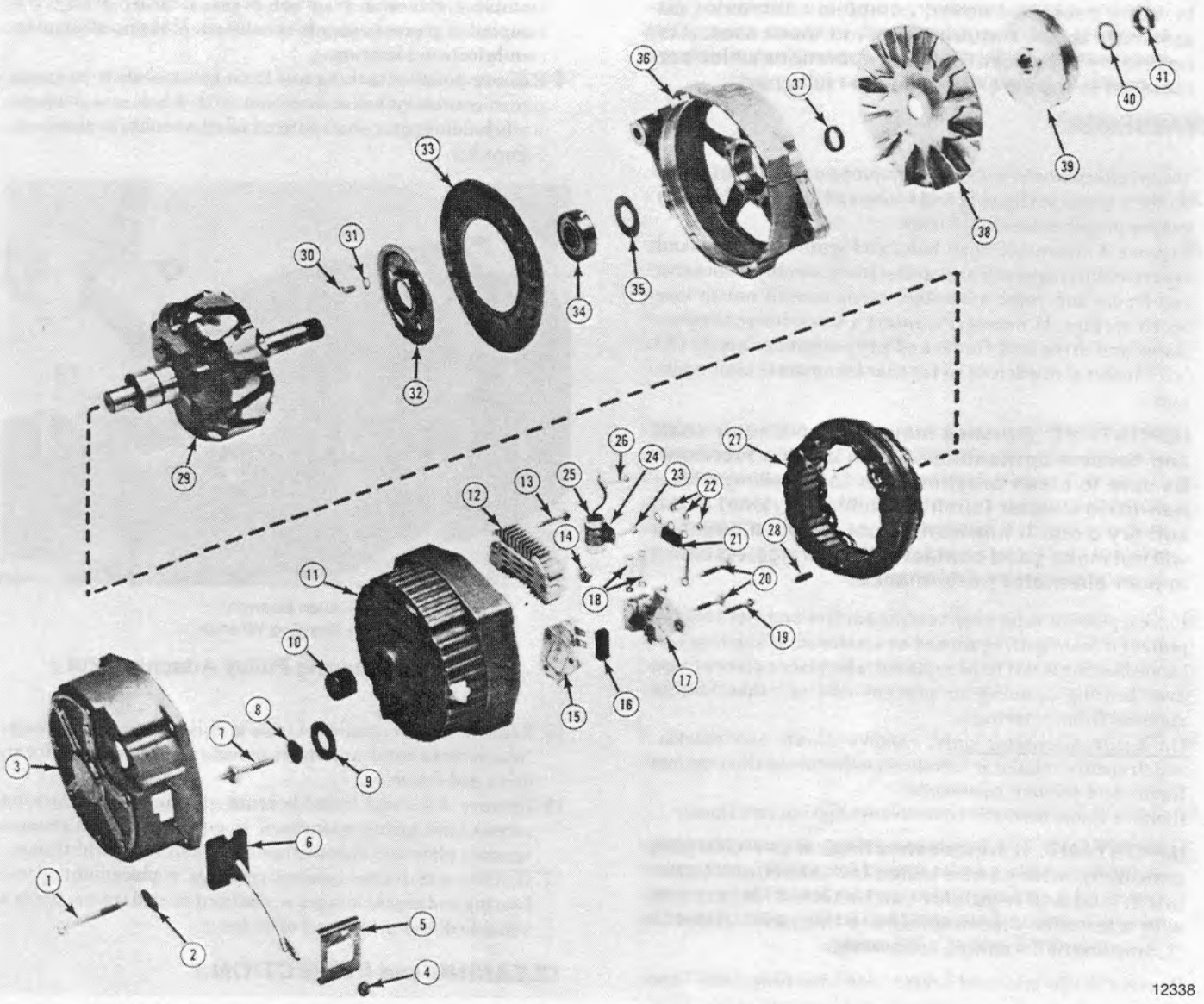
1. Disconnect all battery cables from battery.
2. Disconnect engine wiring harness from alternator.
3. Remove alternator brace to alternator attaching screw, washer(s) and spacer (if used).
4. Loosen alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washer(s) (if used), spacer and nut and remove alternator.



§1 - Screw (7)
2 - Lockwasher (7)
§3 - Flame Arestor Screen
4 - Bolt
5 - Ground Lead Clip
§6 - Flame Arrestor Cover
7 - Screw
8 - Insulator
§9 - Rubber Washer
10 - Bearing
11 - End Frame
12 - Rectifier Bridge
*13 - Spring Washer
14 - Screw and Lockwasher Assembly
15 - Nut
*16 - Jumper Wire
17 - Voltage Regulator
18 - Shorting Clip
*19 - Nut
20 - Brush Holder Assembly
21 - Brush Springs
*22 - Spring Washer
23 - Screw (Ground)
24 - Screws (Insulated)
25 - Diode Trio
26 - Nut (3)
*27 - Spring Washer (3)
28 - Screw
29 - Mounting Bracket
30 - Capacitor
31 - Screw
32 - Stator
§33 - Rubber Plug
34 - Rotor
*35 - Rotor Shaft Inner Collar [11/32" (8.7mm) Thick]
§36 - Screw and Lockwasher Assembly
*37 - Spring Washer (3)
§38 - Bearing Retainer Plate
§39 - Flame Arrestor Screen
40 - Bearing
41 - Grease Slinger Washer
42 - End Frame
43 - Rotor Shaft Outer Collar [7/32" (5.6mm) Thick]
44 - Fan
45 - Pulley
46 - Lockwasher
47 - Nut

** May not be used on some alternators.*
§ Part(s) must be installed for alternator to be properly flame arrested.

Figure 1. 1-Wire Alternator Parts View



1 - Bolt (4)
2 - Ground Lead Clip
§3 - Flame Arrestor Cover
4 - Nut (2)
5 - Bracket
6 - Regulator Terminal Connector
7 - Screw
8 - Insulator
§9 - Rubber Washer
10 - Bearing
11 - End Frame
12 - Rectifier Bridge
13 - Screw and Washer Assembly
14 - Nut
15 - Voltage Regulator
§16 - Rubber Boot
17 - Brush Holder Assembly
18 - Brush Springs
19 - Screw (Ground)
20 - Diode Trio
21 - Diode Trio
22 - Nuts (3)
23 - Screw
24 - Bracket
25 - Capacitor
26 - Screw
27 - Stator
§28 - Rubber Plug
29 - Rotor
§30 - Screw and Lockwasher Assembly (3)
*31 - Spring Washer (3)
§32 - Bearing Retainer Plate
§33 - Flame Arrestor Screen
34 - Bearing
35 - Grease Slinger Washer
36 - End Frame
37 - Rotor Shaft Collar
38 - Fan
39 - Pulley
40 - Lockwasher
41 - Nut

** May not be used on some alternators.*

§ Part(s) must be installed for alternators to be properly flame arrested.

Figure 2. 3-Wire Alternator Parts View

IMPORTANT: The following instructions are for complete disassembly and overhaul of alternator. In many cases, however, complete alternator disassembly is not required and, in those cases, it is necessary to perform only the operations which are required to repair or replace the faulty part.

DISASSEMBLY

1. Mount alternator in a vise by clamping on mounting flange.
2. Scribe a mark on slip ring end frame and drive end frame to ensure proper reassembly later.
3. Remove 4 alternator thru bolts and ground lead clip and separate slip ring end frame and stator assembly from drive end frame and rotor assembly, being careful not to lose brush springs. If necessary, insert a screwdriver between stator and drive end frame and pry assemblies apart. DO NOT insert screwdriver so far that it contacts stator windings.

   IMPORTANT: Brushes may drop onto rotor shaft and become contaminated with bearing lubricant. Be sure to clean brushes prior to installing with a non-toxic cleaner (such as trichlorethylene) and a soft dry cloth. If lubricant is not removed, brushes will not make good contact with slip rings, resulting in poor alternator performance.

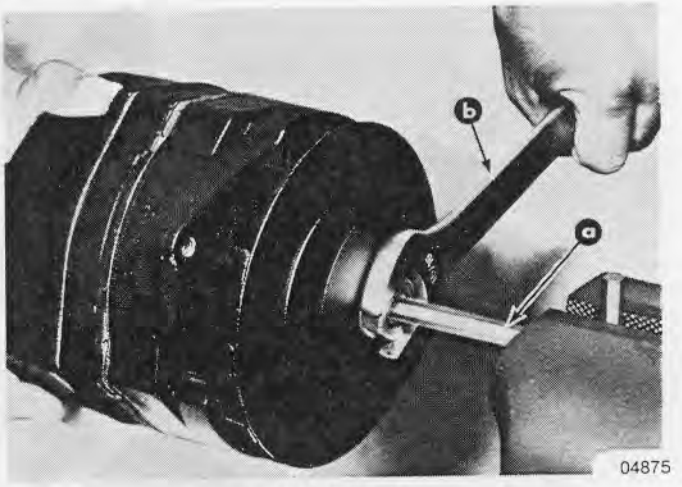
4. Place a piece of tape over bearing surface on rotor shaft to protect it from getting nicked or scratched. If slip ring end frame bearing is not to be replaced, also place a piece of tape over bearing opening to prevent dirt or other foreign material from entering.
5. On 3-wire alternator only, remove 2 nuts and bracket, which secure regulator terminal connector to slip ring end frame, and remove connector.
6. Remove flame arrestor cover from slip ring end frame.

   IMPORTANT: If troubleshooting an overcharging condition, rotor can be tested for a short, and upper brush lead and regulator can be tested for grounds with alternator disassembled to this point. Refer to "Component Testing", following.

7. Remove diode trio and stator lead attaching nuts (and spring washers, if so equipped) and separate stator from slip ring end frame. Remove rubber plug from groove on outside edge of stator frame.
8. Remove insulated screw (and spring washer, if so equipped), which attach diode trio to brush holder assembly, and remove diode trio.
9. Remove capacitor mounting bracket attaching screw and capacitor lead attaching screw and remove capacitor.

   IMPORTANT: With alternator disassembled to this point, stator, rotor, rectifier bridge, diode trio, regulator terminal connector and capacitor can be tested, as explained under "Component Testing", following.

10. Remove screw, washer and nut, which secure rectifier bridge to slip ring end frame, and remove rectifier bridge. Also remove battery terminal screw, insulating washer and sponge rubber washer from end frame.
11. Remove remaining insulated screw and ground screw (and spring washers, if so equipped), which secure brush holder assembly and voltage regulator to slip ring end frame, and remove brush holder assembly and regulator.
12. On 1-wire alternators so equipped, remove nut that secures jumper wire to voltage regulator and remove wire.
13. If slip ring end frame bearing requires replacement, press bearing out of end frame (from outside inward), using a suitable driver and an arbor press. Bearing MUST BE replaced, if grease supply is exhausted. Make no attempt to re-lubricate old bearing.
14. Remove pulley attaching nut from rotor shaft by turning nut in couterclockwise direction with a box end wrench, while holding rotor shaft with an allen wrench, as shown in Figure 3.



a - Allen Wrench
b - Box End Wrench

Figure 3. Removing Pulley Attaching Nut

15. Remove washer, pulley, fan and collar from rotor shaft. Now remove rotor and inner collar (if so equipped) from drive end frame.
16. Remove drive end frame bearing retainer plate attaching screws (and spring washers, if so equipped), then remove retainer plate and flame arrestor screen from end frame.
17. If drive end frame bearing requires replacement, press bearing and grease slinger washer out of end frame, using a suitable driver and an arbor press.

CLEANING and INSPECTION

IMPORTANT: DO NOT clean electrical components with solvent (in next step), as components may be damaged.

1. Clean all electrical components with a clean, soft cloth ONLY. Clean non-electrical components (except slip ring end frame bearing) with solvent and dry with compressed air.
2. Clean brushes with a non-toxic solvent (such as trichlorethylene) and a soft cloth.

   IMPORTANT: Rotor MUST BE spun while cleaning slip rings (in next step). Cleaning the slip rings by hand, without spinning the rotor, may result in flat spots on the slip rings and cause brush noise and excessive slip ring and brush wear.

3. Clean rotor slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. If slip rings are rough or out-of round [.002" (0.05mm) maximum], true slip rings in a lathe, removing only enough material to make rings smooth and round. Finish with 400 grain or finer polishing cloth. If slip

rings are damaged beyond repair, rotor MUST BE replaced.

4. Inspect the following parts for wear and damage -
   a. **Brush and holder assembly**: Inspect for cracked porcelain casing, damaged brush leads, poor brush lead connections, damaged brush lead clips or worn brushes. Brush holder assembly MUST BE replaced, if brushes are less than ¼" (6mm) long.
   b. **Brush holder assembly and voltage regulator insulated attaching screws**: Inspect for missing or damage insulators.

IMPORTANT: If insulator on insulated screws is missing or damaged, no output or uncontrolled alternator output will result during operation.

   c. **Brush springs**: Inspect for corrosion or distortion and check for adequate spring tension.
   d. **Voltage regulator**: Inspect for cracked porcelain case.
   e. **Rotor**: Inspect for damaged threads, scuffed pole piece fingers or damaged bearing surfaces. Rotor MUST BE replaced, if pole pieces are scuffed or bearing surfaces are damaged.
   f. **Drive end frame bearing**: Inspect for roughness, pitting, flat spots, discoloration (due to overheating) or excessive side or end play. Hold inner race of bearing while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
   g. **Drive end frame bearing retainer**: Inspect seal for excessive wear, cracks, roughness or other signs of deterioration.
   h. **Slip ring end frame bearing**: Inspect for flat spots, pitting or discoloration due to overheating. Inspect bearing seal for cracks, flat spots, roughness or other signs of deterioration. Entire bearing MUST BE replaced, if seal is damaged. Also check bearing for adequate lubrication. If grease supply is exhausted, bearing MUST BE replaced. Make no attempt to re-lubricate bearing.
   i. **End frames**:Inspect for cracks, distortion, stripped threads or wear in bearing bore due to a spun bearing. End frame(s) MUST BE replaced, if bearing(s) have spun.
   j. **Stator**: Inspect for damaged insulation or wires. Also, inspect insulation for heat discoloration, as this usually is a sign of a shorted or grounded winding.
   k. **Fan**: Inspect for cracked or bent fins or broken welds on bi-rotational fans.
   l. **Pulley**: Inspect pulley sheaves for rotational trueness, undercut surfaces (from excessive wear), nicks, pitting or corrosion. Repair surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair. Drive surfaces MUST BE perfectly true and smooth, or drive belt wear will be greatly accelerated.

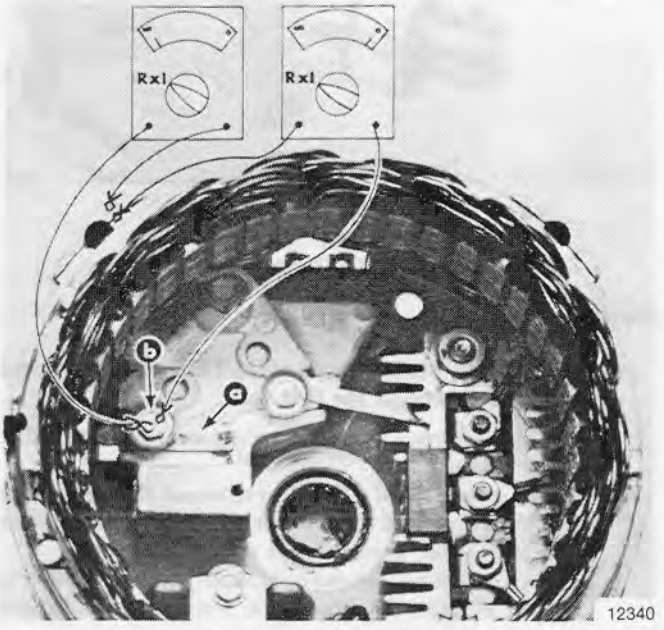
COMPONENT TESTING

Upper Brush Lead Clip and Regulator Ground Test

IMPORTANT: The following test need be performed only if an overcharging condition exists.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to upper brush lead clip and the other lead to slip ring end frame, as shown in Figure 4. Note ohmmeter reading.
2. Reverse ohmmeter leads and again note reading.
3. If both readings are zero, either upper brush lead clip is grounded or voltage regulator is defective. A grounded brush lead clip can result from a damaged or missing insulator on insulated screw that secures upper brush lead clip. Remove screw and inspect insulator. If satisfactory, replace voltage regulator.

IMPORTANT: Some older alternators may have an insulated screw with a separate insulating sleeve and washer instead of a one-piece insulator. On these alternators, be sure that both insulating sleeve and washer are not missing or damaged.



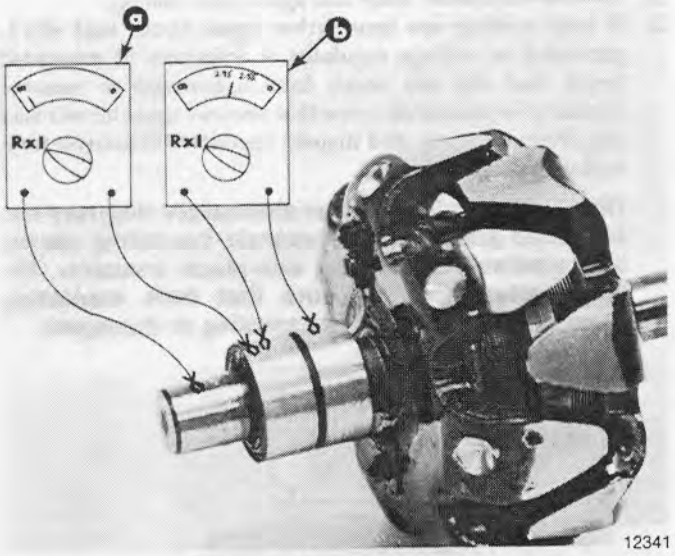
a - Upper Brush Lead Clip
b - Insulated Screw

Figure 4. Testing for Grounded Brush Lead Clip or Defective Regulator

Rotor

1. Test rotor field circuit for grounds, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft. (Figure 5)
   b. Meter should indicate no continuity (meter should not move).
   c. If continuity exists, rotor field is grounded and rotor must be replaced.
2. Test rotor field for shorts or opens, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect one ohmmeter lead to each slip ring. (Figure 5)
   b. Ohmmeter reading should be 2.55 to 2.95 ohms with rotor at room temperature [60° - 80° F (16° - 27° C)].
   c. If reading is low, rotor field is shorted. If reading is high or infinite (no meter movement), high resistance or an open exists in field. In either case, rotor must be replaced.

IMPORTANT: If alternator has output at low speed but no output at high speed, rotor field winding may be shorting or grounding out due to centrifugal force. Replace rotor if this situation exists, and if all other electrical components test good.



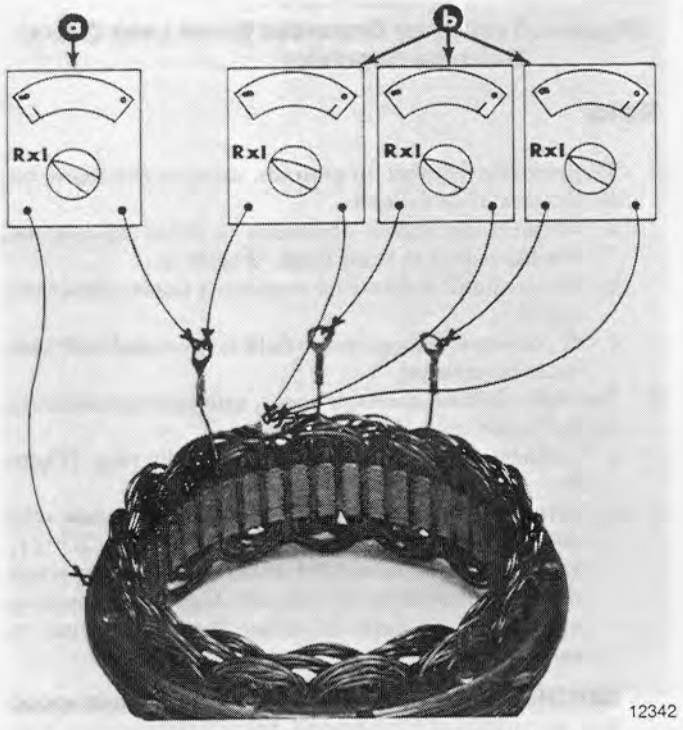
a - Test for Grounds
b - Test for Shorts or Opens

Figure 5. Testing Rotor Field Circuit

Stator

IMPORTANT: Stator leads MUST BE disconnected from rectifier bridge for this test.

1. Test stator for grounds, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. (Figure 6) Be sure that leads make good contact with stator frame.
   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.



a - Testing for Grounds
b - Testing for Opens

Figure 6. Testing Stator Windings

2. Test for opens in stator, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect ohmmeter between junction clip and each of the stator winding lead terminals (3 different ways). (Figure 6)
   b. Continuity should exist in all 3 cases (meter should move) If it does not, a winding is open and stator must be replaced.
3. A short in the stator is difficult to detect without special laboratory equipment due to the low resistance of the windings. If all other electrical components test out good, and alternator fails to produce rated output but will produce a minimum of 5 amps output, stator probably is shorted and should be replaced.

Rectifier Bridge

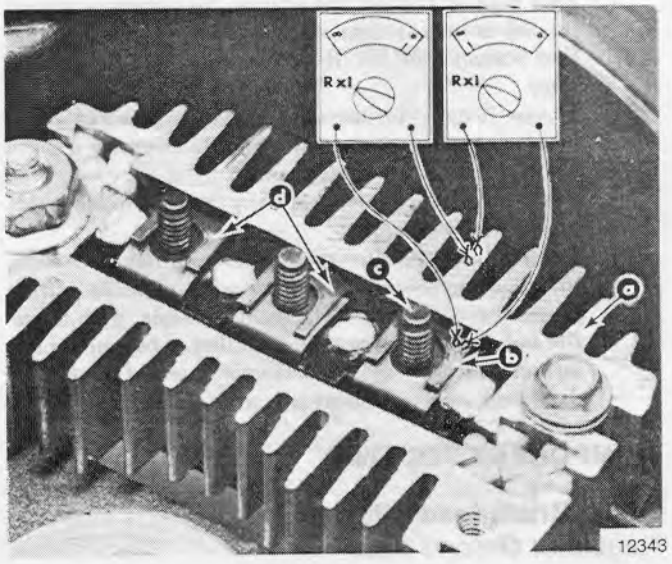
IMPORTANT: Rectifier bridge can be tested while installed in end frame. Stator and diode trio, however, MUST BE removed.

⚠CAUTION

DO NOT use a test instrument with more than a 12-volt source (in the following test), as rectifier bridge may be damaged.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to negative (grounded) heat sink and the other lead to one of the negative (-) heat sink diode leads. (Figure 7)

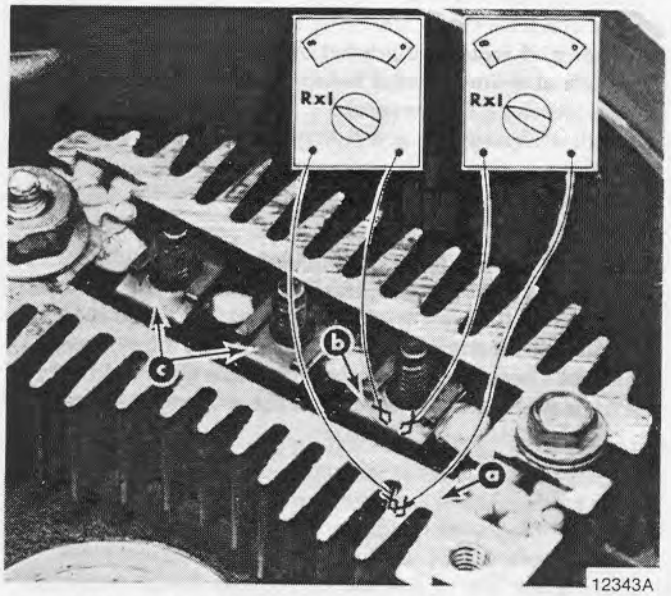
IMPORTANT: DO NOT connect ohmmeter test lead directly to rectifier bridge terminal studs, as diode leads may not be making good contact with studs with terminal nuts removed.



a - Negative (Grounded) Heat Sink
b - Negative (-) Heat Sink Diode Lead
c - DO NOT Connect Test Lead to Stud
d - Repeat Same Test for These 2 Negative Heat Sink Diode Leads

Figure 7. Testing Negative Heat Sink Diodes

2. Reverse test leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement), when connected one way, and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.



a - Positive (Insulated) Heat Sink
b - Positive (+) Heat Sink Diode Lead
c - Repeat Test for These 2 Positive Heat Sink Diode Leads

Figure 8. Testing Positive Heat Sink Diodes

4. Repeat same test between negative (-) heat sink and 2 other negative heat sink diode leads. (Figure 8) Also repeat test between positive (insulated) heat sink and each of the 3 positive (+) heat sink diode leads, as shown in Figure 8.
5. Replace complete rectifier bridge, if any one of the diodes is shorted or open.

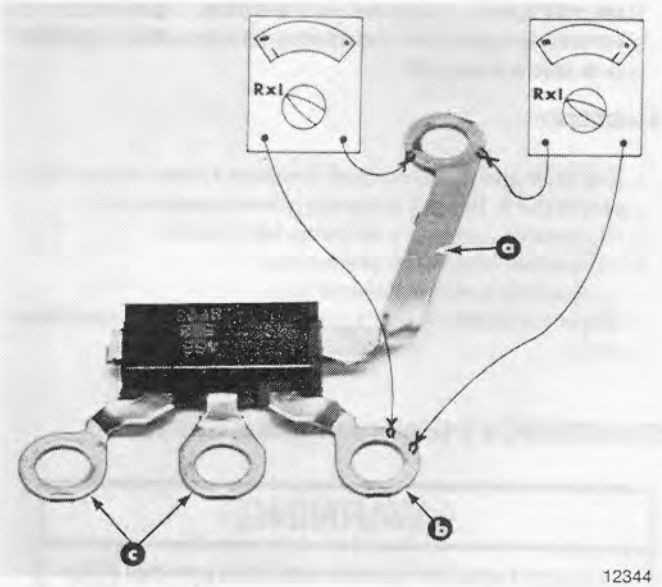
Diode Trio

IMPORTANT: Diode trio MUST BE removed from slip ring end frame for this test.

⚠CAUTION

DO NOT use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damage.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to long connector and the other lead to one of the 3 short connectors. (Figure 9) Note ohmmeter reading.
2. Reverse ohmmeter leads and again note reading.
3. Meter should indicate a high or infinite reading, when meter is connected one way, and a low reading when meter is connected the other way. If both readings are high or infinite, diode (in diode trio) is open. If both readings are low, diode is shorted.
4. Repeat same test between long connector and other 2 short connectors.
5. Replace diode trio if ANY of the diodes (in diode trio) are shorted or open.

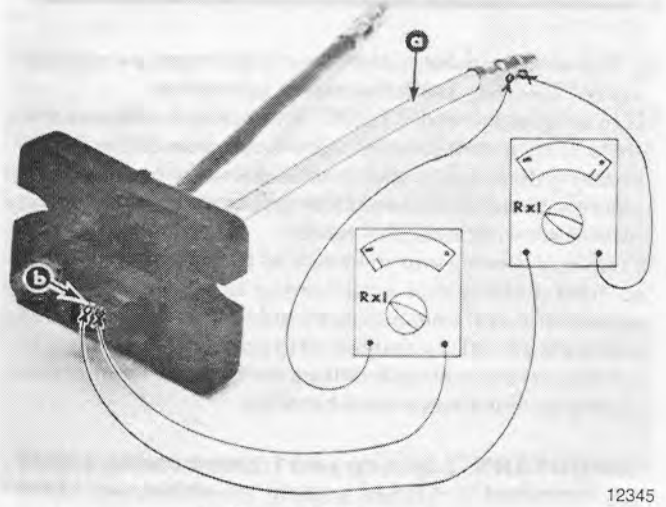


a - Long Connector
b - Short Connector
c - Repeat Test between Long Connector and These 2 Short Connectors

Figure 9. Testing Diode Trio

Regulator Terminal Connector (3-Wire Alternator Only)

1. Check excitation lead diode in regulator terminal connector for shorts or opens by connecting one lead of an ohmmeter (set on Rx1 scale) to white lead bullet connector and other lead to corresponding terminal in connector. (Figure 10) Note ohmmeter reading.
2. Reverse ohmmeter leads and again note reading.
3. Meter should indicate a high or infinite reading (no meter movement), when meter is connected one way, and a low reading when meter is connected the other way. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. If diode is shorted or open, terminal connector MUST BE replaced.



a - Purple (White)
b - Purple (White) Terminal

Figure 10. Testing Regulator Terminal Connector Diode

IMPORTANT: If diode in terminal connector is shorted, engine will continue to run after ignition has been turned off.

Capacitor

1. Using Magneto Analyzer and accompanying instructions, perform the following capacitor (condenser) tests:
   a. Capacitor capacity test (must be .5 mfd).
   b. Capacitor short or leakage test.
   c. Capacitor series resistance test.
2. Replace capacitor, if test results are not within specifications.

REASSEMBLY (Refer to Figure 1 or 2)

⚠WARNING

All parts, that are marked with the symbol (§)in Figures 1 and 2 MUST BE reinstalled for alternator to be properly flame-arrested.

1. Fill drive end frame bearing one-quarter full with Ball Bearing Lubricant (Delco Part No. 1948791). DO NOT over-fill, as this may cause bearing to overheat.
2. Place grease slinger washer into recess in drive end frame bearing bore, then press bearing into end frame (with open end upward), using a bearing driver that contacts outer bearing race only.
3. Install flame arrestor screen (if so equipped) in drive end frame, then install retainer plate and secure with 3 screws (and spring washers, if so equipped). Tighten screws securely. Shape edges of flame arrestor screen to fit snugly against inside contour of end frame.

⚠WARNING

Flame arrestor screen MUST fit snugly against inside contour of end frame or flame arresting property of screen will be lost.

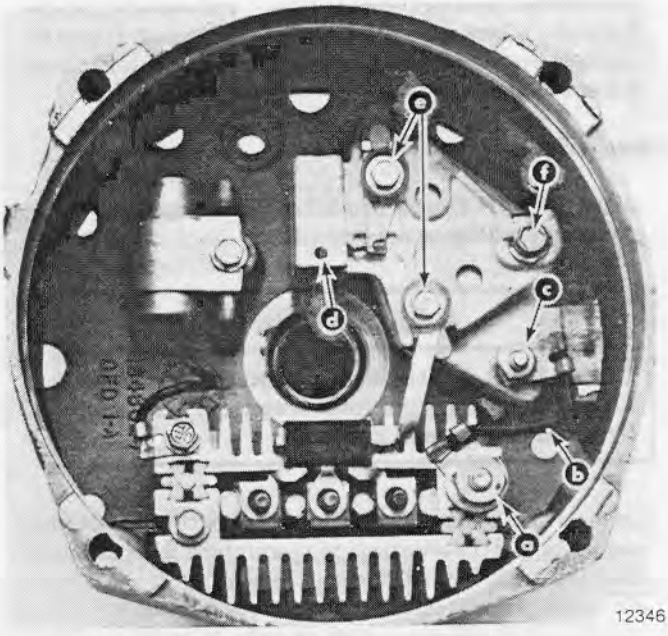
4. If not already done, clean rotor slip rings as explained under "Cleaning and Inspection", preceding.
5. If so equipped, install 11/32" (9mm) thick collar on rotor shaft, then install rotor in drive end frame. Place 7/32" (6mm) collar, fan, pulley and lockwasher on shaft and secure with nut. Torque nut to specifications while holding rotor shaft with an allen wrench.
6. Press new bearing into slip ring end frame with a flat plate or other suitable tool until bearing is flush with outside surface of end frame. Support inside of end frame around bearing bore with a suitable tool to prevent distortion. Use extreme care to prevent bearing misalignment or otherwise placing undue stress on the bearing.

IMPORTANT: Slip ring end frame bearing MUST BE replaced, if grease supply is exhausted. Make no attempt to re-lubricate bearing. Also, DO NOT lubricate new bearing, as bearing is lubricated at the factory, and additional lubricant will ooze out and get on slip rings when alternator is reassembled.

7. Place rectifier bridge in position in slip ring end frame and secure with battery ("BAT") terminal screw, insulator and nut on one end and screw (and spring washer if so equipped) on the other. On alternators so equipped, also install rectifier bridge to regulator jumper wire under rectifier bridge attaching nut, as shown in Figure 11. Tighten attaching nut and attaching screw securely.
8. Slide condenser into mounting bracket, then install condenser and mounting bracket assembly in slip ring end frame and connect lead to rectifier bridge. Tighten capacitor attaching screws securely.
9. Install shorting clip (on 1-wire alternators) or sponge rubber boot (on 3-wire alternator) over voltage regulator terminals and place regulator in position in slip ring end frame.

IMPORTANT: Before installing brushes in brush holder (in next step), clean brushes with a non-toxic cleaner (such as triclorethylene) to remove any residue that may exists. If residue is not removed, brushes may not make good contact with slip rings, which will result in poor alternator performance.

10. Insert brush springs and brushes into brush holder and hold them in place by inserting a toothpick or piece of wire thru holes in brush holder. Place brush holder assembly in position on top of regulator with toothpick or wire protruding thru hole in slip ring end frame. (Figure 11)
11. Place diode trio in position on rectifier bridge terminals and center diode trio connector over attaching hole in brush holder assembly.
12. Secure diode trio connector, brush holder assembly and voltage regulator with 2 insulated screws and ground screw (and 3 spring washers, if so equipped), as shown in Figure 11. Tighten screws securely.



a - Rectifier Bridge Attaching Nut
b - Rectifier Bridge to Regulator Jumper Wire (if so Equipped)
c - Regulator Terminal Nut
d - Toothpick or Wire Retaining Brushes
e - Insulated Screws
f - Ground Screw

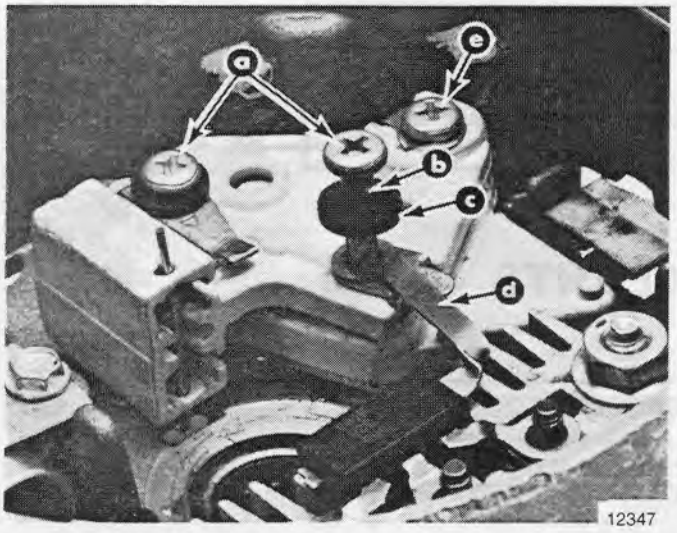
Figure 11. Voltage Regulator and Brush Holder Assembly Installed (Alternator with Jumper Wire Shown)

IMPORTANT: Insulated screws (used on most alternators) have a one piece insulator permanently attached to screw body. Some alternators, however, may have insulated screws with only an insulating sleeve over screw body, and a separate insulating washer also is required. Install screw and insulating washer as shown in Figure 12.

⚠CAUTION

Two insulated screws and ground screw MUST BE installed as shown in Figure 11 and 12. If ground screw and either of the insulated screws are reversed (or if insulating washers are missing), a ground will result, causing no output or uncontrolled output.

13. On alternators so equipped, connect jumper wire (installed in Step 7) to terminal on regulator and secure with nut. (Figure 11) Tighten nut securely.

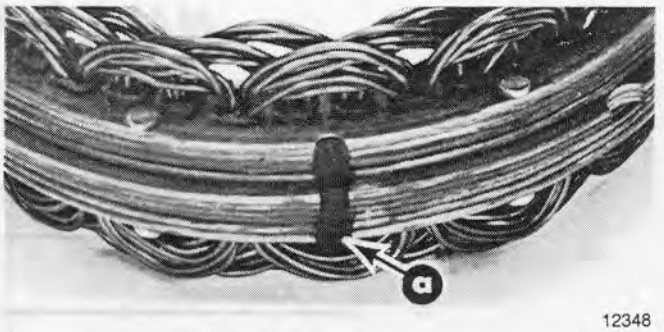


12347

a - Insulated Screws
b - Insulating Sleeve (Attached to Screw)
c - Insulating Washer
d - Install Diode Trio Connector under Insulating Washer
e - Ground Screw

Figure 12. Installing Insulated Screws with 2-Piece Insulators

14. Install rubber plug into groove on outside edge of laminated core stator, as shown in Figure 13. Position stator in slip ring end frame with stator leads over rectifier bridge terminals. Install 3 stator lead attaching nuts (and spring washers, if so equipped). Tighten nuts securely. Rotate slightly, if necessary, to align 4 grooves in stator frame with thru bolt holes in end frame.
15. Remove tape that was placed over slip ring end frame bearing and rotor shaft bearing surface during disassembly. Clean bearing surface on rotor shaft to remove any residue, then align scribed marks on end frames (scribed during disassembly) and assembly alternator. DO NOT install thru bolts at this time.



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a - Rubber Plug

Figure 13. Rubber Plug Installed in Stator Laminated Core

16. Remove toothpick or wire from brush holder (thru hole in slip ring end frame) to allow brushes to contact slip rings.
17. Install sponge rubber washer over battery ("BAT") terminal screw insulator. Place flame arrestor cover over slip ring end frame and install 4 thru bolts and ground clip. Tighten bolts securely.
18. On alternators with a removable slip ring end frame flame arrestor screen, reinstall screen (if removed) and secure with 7 screws and lockwashers. Tighten securely.

⚠WARNING

ALL 7 slip ring end frame flame arrestor screen attaching screws MUST BE installed, or alternator will not be properly flame-arrested.

19. On 3-wire alternator only: Plug regulator terminal connector into slip ring end frame and secure with attaching bracket and 2 nuts. Tighten nuts securely.

INSTALLATION

1. Position alternator in mounting bracket and install mounting bolt, washers (if used), spacer and nut. Place washers (if used) on each side of spacer. DO NOT tighten nut at this time.
2. Fasten alternator brace to alternator with bolt, washer and spacer (if used). DO NOT tighten at this time.
3. Place alternator drive belt on pulleys and adjust tension as explained under "Drive Belt Tension Adjustment".

⚠WARNING

DO NOT use an open flame when installing heat shrink tubing (in next step) to prevent the possibility of an explosion and/or a fire.

4. Reconnect wiring harness to alternator. On 3-wire alternators, insulate red/purple (red) lead and purple (white) lead bullet connections with heat shrink tubing or at least 4 layers of electrical tape.
5. Reconnect battery cables to battery.

MANDO ALTERNATOR

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace To Alternator		192 (28)
Alternator Brace To Block	30 (41)	
Alternator To Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
Brush Retaining Screws	Securely	
Pulley Nut	50 (68)	
Rectifier Heat Sinks	Securely	
Regulator Retaining Screws	Securely	
Thru Bolts	Securely	

TOOLS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-31229A5	Bearing Removal and Installation Kit
91-76032	Magneto Analyzer
91-37241	Universal Puller Plate
91-99750	Volt/Ohmmeter

TOOLS PURCHASED LOCALLY
Ammeter (0-50 Amps)

SEALANTS	
92-25711	Quicksilver Liquid Neoprene

SPECIFICATIONS

Mercury Number (Mando Number)	Amp Output (Max.)	Rotation
98555 (AR150AA)	55	Uni-Directional

DESCRIPTION

The alternator system, used on engines with Mando Alternators, consists of the alternator, battery, the ignition switch and the wiring which connects these components. Refer to "Section 3 Part F" for wiring diagrams.

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven (via a pulley) at approximately twice engine speed. The rotor contains a field winding that is enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 6 diodes which are arranged so that current flows from ground, thru the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifier and stator. A capacitor also is utilized to protect the rectifier system from high voltages and to suppress radio noise.

PRECAUTIONS

The following precaution MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the "Troubleshooting Tests".
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (-) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and the positive (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used. BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

PERIODIC MAINTENANCE

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connections.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under "Drive Belt Tension Adjustment".
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.

TROUBLESHOOTING TESTS (ALTERNATOR ON ENGINE)

Use the following tests in conjunction with the "Troubleshooting" in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe "Precautions", immediately preceding, to prevent damage to alternator system.

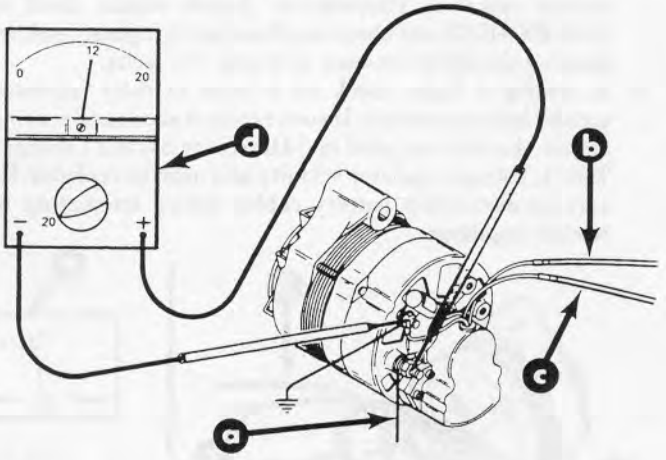
1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined under "Storage Battery" in "Section 3 Part A". Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive belt tension and adjust if necessary, as outlined under "Drive Belt Tension Adjustment".

CIRCUITRY TEST

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

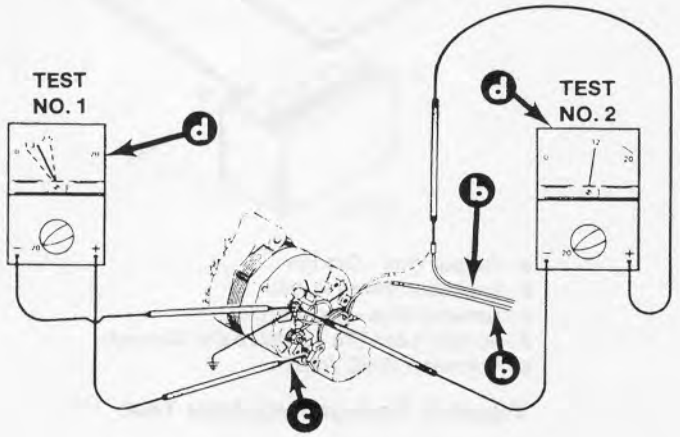
Output Circuit

1. Connect positive voltmeter lead to alternator output terminal and negative lead to ground terminal on alternator. (Figure 1)
2. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximately battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or damaged wiring.



a - Output Wire - Orange
b - Excitation Wire - Purple
c - Sensing Wire - Red/Purple
d - Voltmeter (0-20 Volts)

Figure 1. Alternator Output Circuit Test



a - Excitation Wire - Purple
b - Sensing Wire - Red/Purple
c - Green Wire
d - Voltmeter (0-20 Volts)

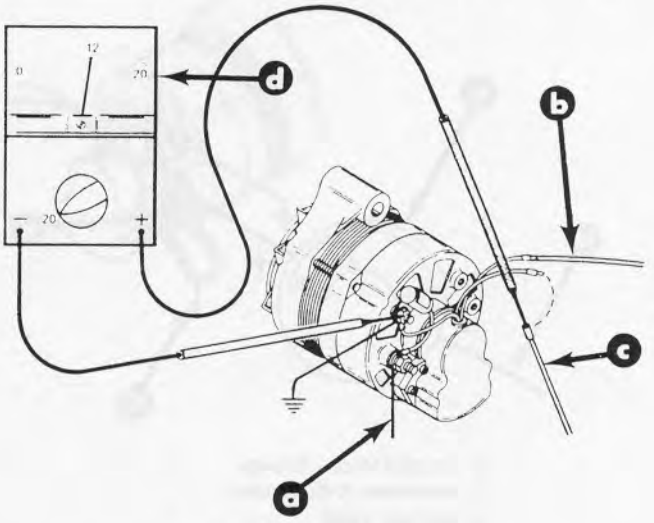
Figure 2. Alternator Excitation Circuit Test

Excitation Circuit

1. Remove 4 screws which secure the regulator to the alternator.
2. Connect positive (+) voltmeter lead to regulator terminal (green wire) on alternator and negative (–) lead to ground terminal on alternator. (Test No. 1 in Figure 2)
3. Turn ignition switch to "On" position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
4. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug purple lead from regulator. Connect positive voltmeter lead to purple lead and negative voltmeter lead to ground. (Test No. 2 in Figure 2) If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.
5. If reading is between .75 and 1.1 volts, rotor field circuit probably is shorted or grounded. Disassemble alternator and test rotor as outlined under "Alternator Repair", following.
6. If reading is between 6.0 and 7.0 volts, rotor field circuit probably is open. Remove regulator and inspect for worn brushes or dirty slip rings. Replace brushes if less than ¼" (6mm) long. If brushes and slip rings are in good condition, disassemble alternator and test rotor, as outlined under "Alternator Repair".

Sensing Ciruit

1. Unplug red/purple lead from voltage regulator.
2. Connect positive voltmeter lead to red/purple lead and negative voltmeter lead to ground terminal. (Figure 3)
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/purple lead) for loose or dirty connections or damaged wiring.



a - Output Wire - Orange
b - Excitation Wire - Purple
c - Sensing Wire - Red/Purple
d - Voltmeter (0-20 Volts)

Figure 3. Regulator Sensing Circuit Test

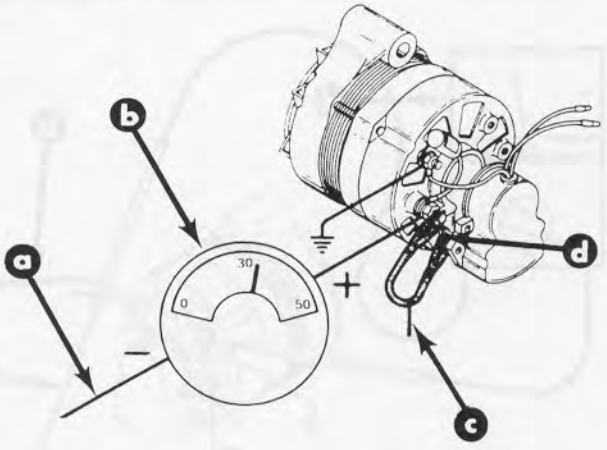
CURRENT OUTPUT TEST

Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (-) battery cable from battery.
2. Disconnect orange lead from alternator output terminal and connect ammeter in series between lead and output terminal. (Figure 4) Connect positive (+) side of ammeter toward output terminal.
3. Reconnect negative battery cable.
4. Remove coil hi-tension lead from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.
5. Turn off accessories and reinstall coil hi-tension lead. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper lead between alternator output terminal and regulator terminal. (Figure 4) Repeat Steps 4 and 5.
7. If reading is now within specifications, diode trio is faulty. Disassemble alternator and replace diode trio, as explained under "Alternator Repair", following.
8. If reading is still low with jumper lead connected, perform "Voltage Regulator Test" following, to determine if fault is in regulator or alternator.



a - Output Wire - Orange
b - Ammeter (0-50 Amps)
c - Jumper Lead
d - Regulator Terminal (Green Wire)

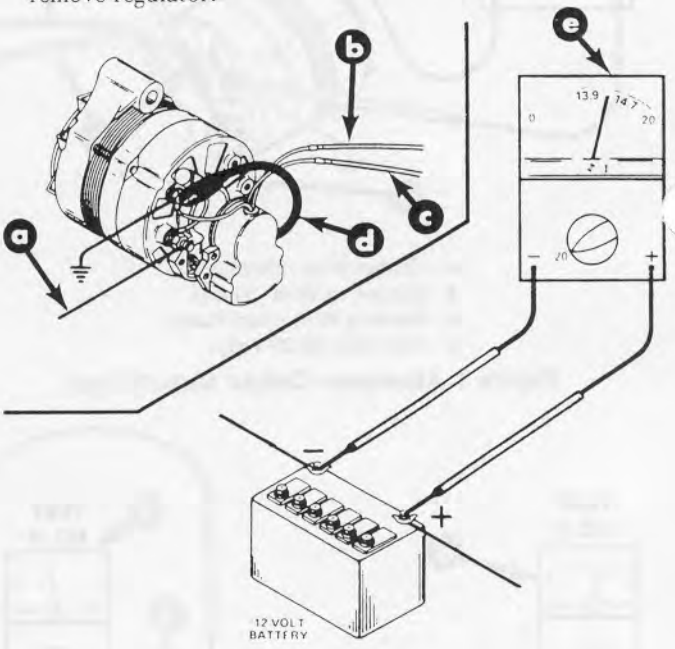
Figure 4. Alternator Current Output Test

VOLTAGE OUTPUT TEST

Perform this test to determine if voltage regulator is operating correctly, using a 0-20 volt DC voltmeter.

IMPORTANT: Battery MUST BE fully charged (1.260 or above specific gravity) to obtain proper voltage reading in this test. If necessary, charge battery with a battery charger or allow engine to run a sufficient length of time to fully charge battery before taking reading.

1. Connect positive (+) voltmeter lead to positive battery terminal and negative (-) voltmeter lead to negative terminal. (Figure 5)
2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7 volts.
3. If reading is high, check for a loose or dirty regulator ground lead connection. If connection is good (and sensing circuit checked out good in "Alternator System Circuitry Test"), voltage regulator is faulty and must be replaced. Be sure to disconnect battery cables before attempting to remove regulator.



a - Output Wire - Orange
b - Excitation Wire - Purple
c - Sensing Wire - Red/Purple
d - Jumper Lead (To Tan Wire and Ground)
e - Voltmeter (0-20 Volts)

Figure 5. Voltage Regulator Test

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the next steps) to prevent the possibility of an explosion and/or fire, should a spark occur.

⚠CAUTION

DO NOT allow jumper wire to contact alternator end frame (in next step), as diode trio and regulator may be damaged.

4. If reading is low, stop engine and remove 4 regulator attaching screws. Pull regulator away from alternator end frame to gain access to field regulator terminals. DO NOT disconnect regulator terminals. Connect a jumper lead from the ground stud to the brush terminal that has a tan wire attached. (Figure 5) Restart engine and gradually increase engine speed to 1500 RPM while observing voltmeter. DO NOT allow voltage to exceed 16 volts.
5. If a voltmeter reading of 14.5 volts or above is now obtained, voltage regulator is faulty and must be replaced. If voltmeter reading is below 14.5 volts, inspect brushes and slip rings for wear, dirt or damage. If brushes and slip rings are good, alternator is faulty internally. Disassemble alternator and test components, as outlined under "Alternator Repair", following.

ALTERNATOR REPAIR

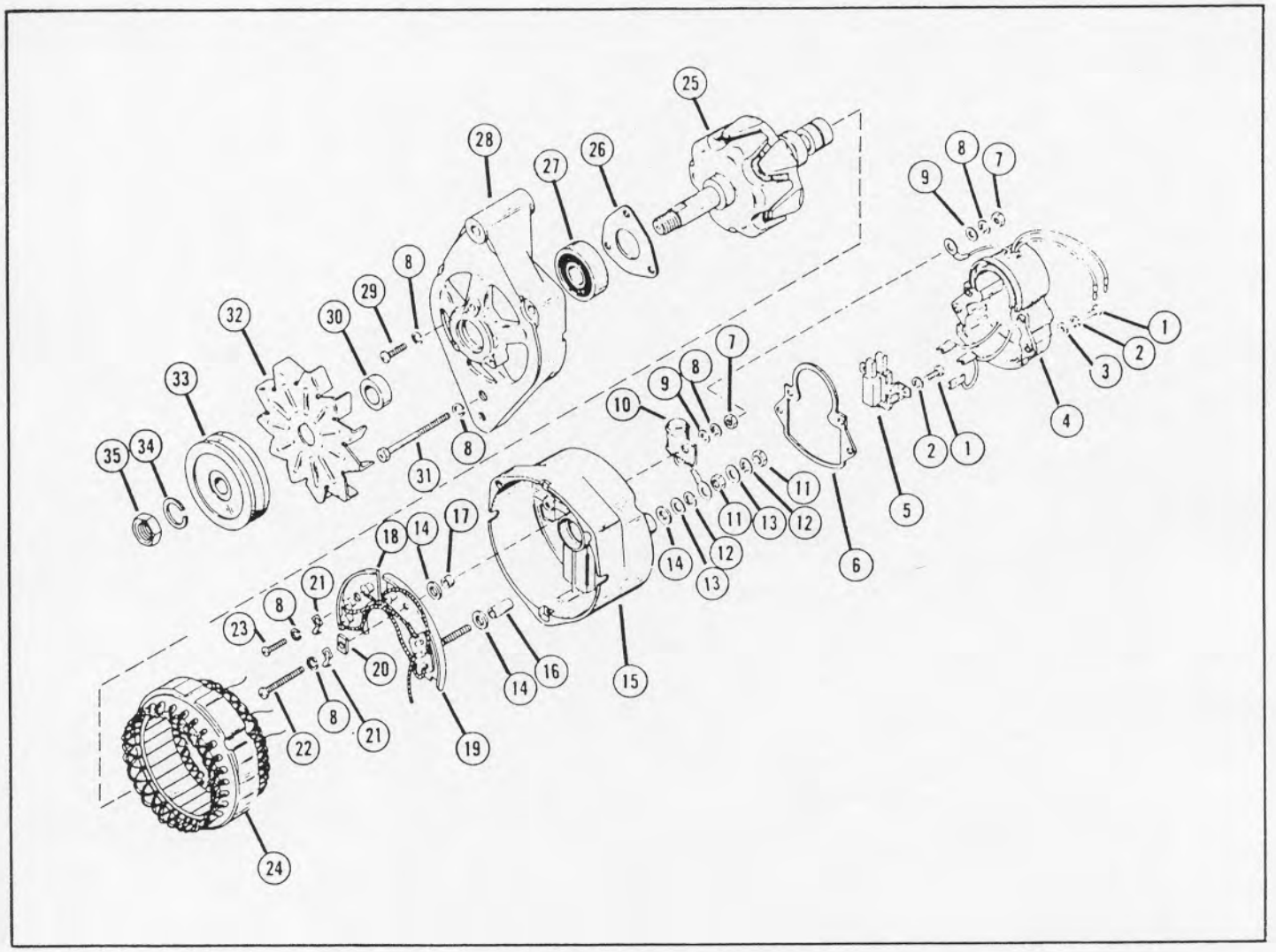
REMOVAL

1. Disconnect negative (–) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator brace to alternator attaching bolt, washer(s) and spacer (if used).
4. Loosen alternator brace to engine attaching bolt and alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washers (if used), spacer and nut and remove alternator.

DISASSEMBLY

IMPORTANT: the following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

1. Mount alternator in a vise so that rear end frame is facing you.
2. Disconnect regulator leads from terminals on rear end frame. Remove 4 regulator attaching screws, then pull regulator away from rear end frame and disconnect regulator field leads. Remove regulator rubber seal.
3. Remove 2 brush set attaching screws and remove brush set.



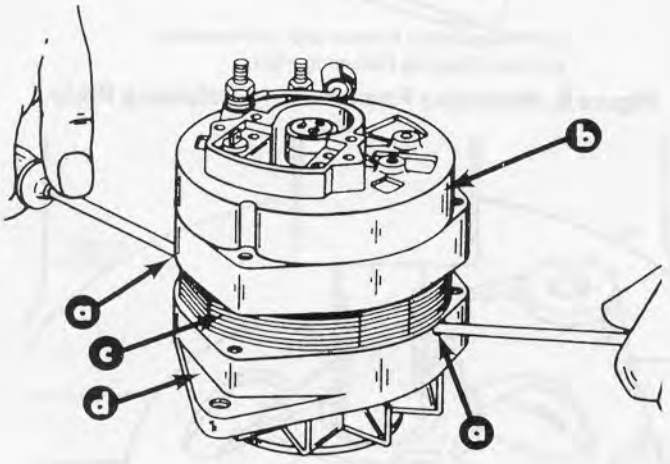
1. Screw (6)
2. Lockwasher (6)
3. Flatwasher (4)
4. Regulator
5. Brush Set
6. Rubber Seal
7. Nut
8. Lockwasher (6)
9. Flatwasher (2)
10. Condenser
11. Nut
12. Lockwasher (2)
13. Flatwasher (2)
14. Insulating Washer (3)
15. End Frame
16. Insulating Sleeve - Long
17. Insulating Sleeve - Short
18. Negative (–) Rectifier
19. Positive (+) Rectifier
20. Insulator - Rectangular
21. Clip (2)
22. Screw (1)
23. Screw (2)
24. Stator
25. Rotor
26. Retaining Plate
27. Front Bearing
28. End Frame
29. Screw (3)
30. Spacer
31. Screw (3)
32. Fan
33. Pulley
34. Lockwasher
35. Nut

Figure 1. Mando Alternator Parts View

4. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.
5. Remove 3 screws which secure end frames and stator together.

IMPORTANT: DO NOT insert screwdriver blades more than 1/16" (1.6mm) into openings (in next step), as stator windings may be damaged.

6. Separate rear end frame and stator assembly from front end frame and rotor assembly using 2 thin blade screwdrivers (positioned at 180° apart from one another) at the location shown in Figures 2 and 3. Use the two slots, shown in Figure 2, to initially separate units.



a - DO NOT Insert Screwdriver Blades More than 1/16" into Slots
b - Rear End Frame
c - Stator
d - Front End Frame

Figure 2. Separating Rear End Frame and Stator Assembly from Front End Frame and Rotor Assembly

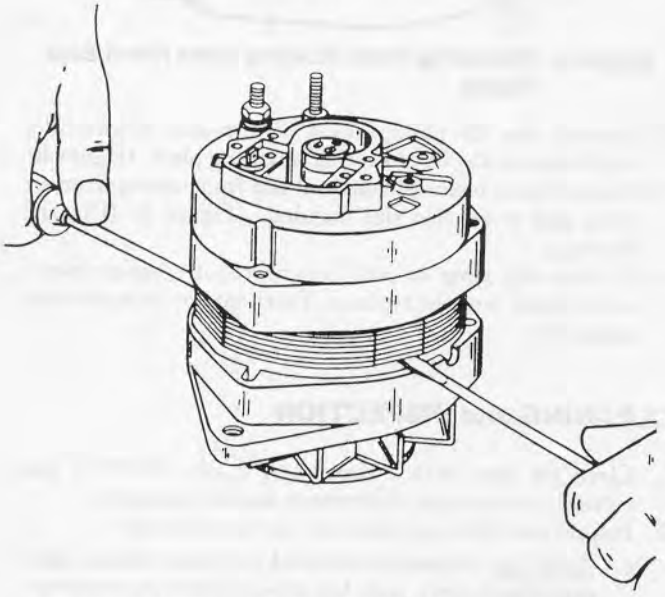
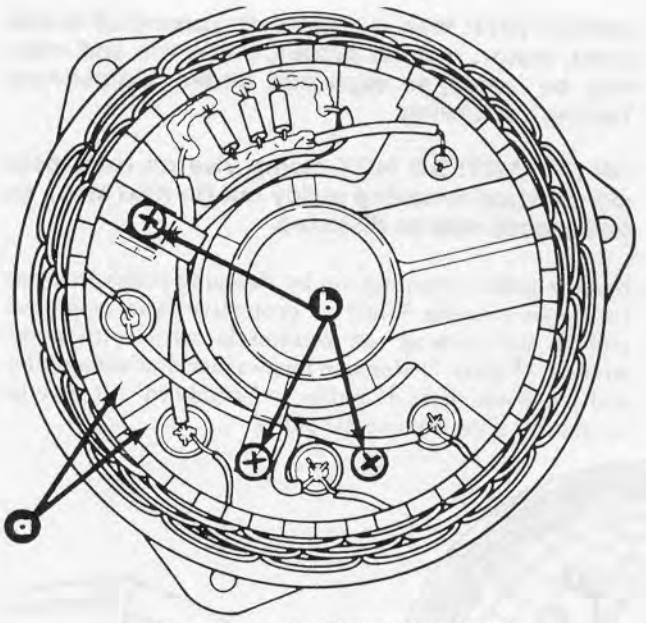
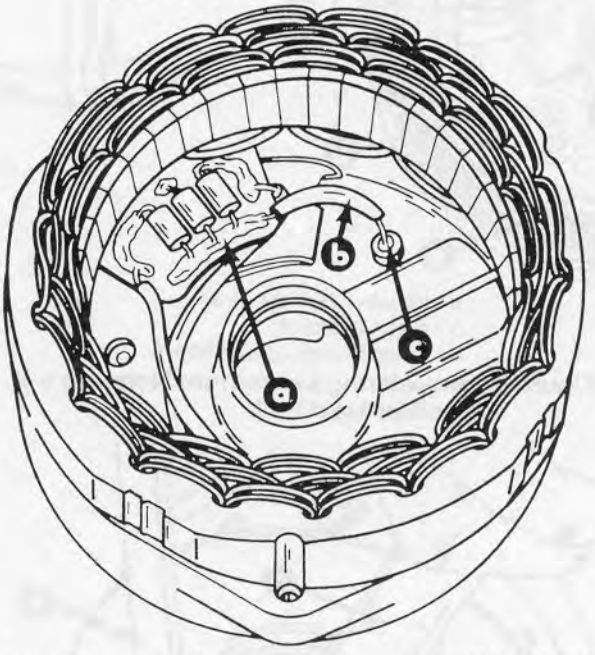


Figure 3. Separating Rear End Frame and Stator Assembly from Front End Frame and Rotor Assembly



a - Rectifiers b - Phillip Head Screws

Figure 4. Removing Rectifiers



a - Diode Trio b - Diode Trio Lead c - Insulated Terminal

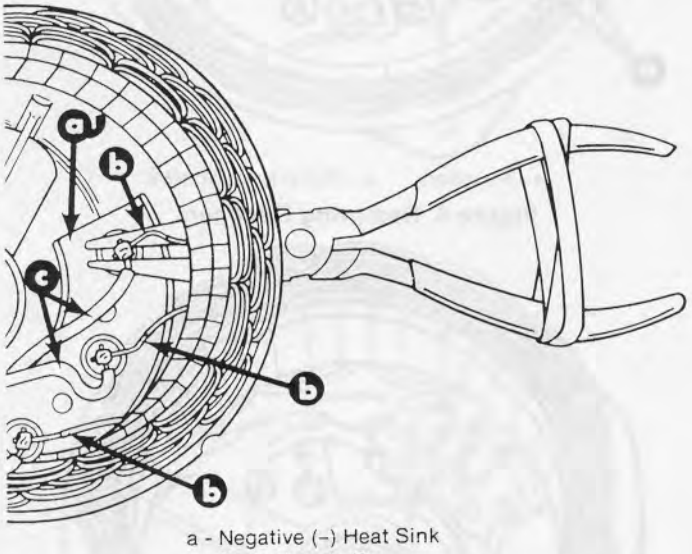
Figure 5. Diode Trio Lead Removal

7. Place rear end frame and stator assembly on the bench with stator downward. Be sure that bench is clean and free of metal chips. Remove nuts, washers, insulators and condenser from output and ground studs.
8. Turn end frame over (stator upward) and remove the three phillips head screws which secure rectifiers to end frame. (Figure 4)
9. Unsolder diode trio lead from the insulated regulator terminal. (Figure 5)
10. Unsolder the three (3) stator leads along with the three (3) coated leads from the negative (-) rectifier heat sink. (Figure 6) Place a needle nose pliers on diode terminal between solder joint and diode body (as shown in Figure 6) to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.

IMPORTANT: With alternator disassembled to this point, stator, rectifier diodes, diode trio and rotor may be tested, as explained under "Component Testing", following.

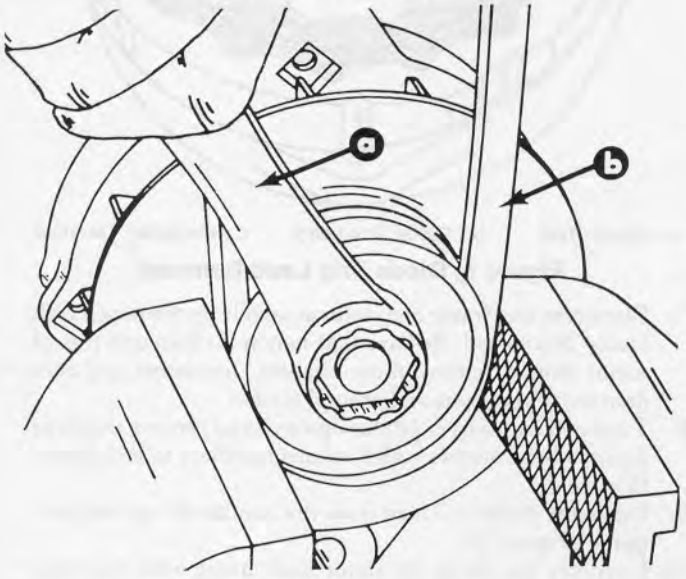
IMPORTANT: DO NOT clamp vise on rotor pole pieces when removing pulley nut (in next step), as pole pieces may be distorted.

11. Remove pulley retaining nut by clamping pulley in a vise (using an oversize V-belt or protective jaws to protect pulley) and turning nut counterclockwise with a 7/8" wrench. (Figure 7) Remove lockwasher and slide pulley and fan from shaft. If pulley is "stubborn", it may be necessary to use a universal puller.



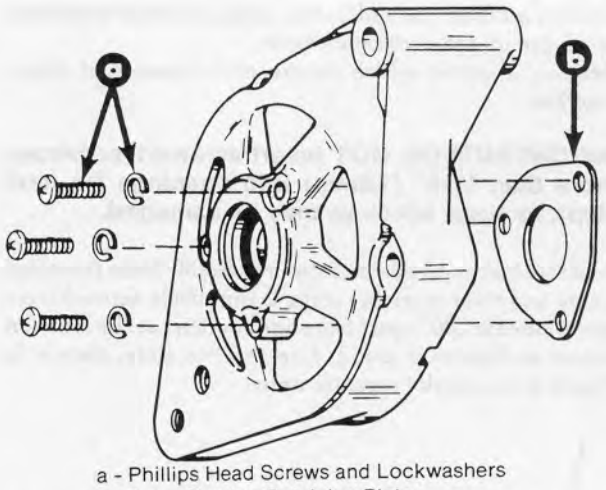
a - Negative (-) Heat Sink
b - Stator Leads (3)
c - Coated Leads (3) (2 Shown)

Figure 6. Unsoldering Leads from Negative (-) Rectifier Heat Sink



a - 7/8" Wrench
b - Use Oversize V-Belt to Protect Pulley

Figure 7. Removing Pulley Nut



a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

Figure 8. Removing Front Bearing Retaining Plate

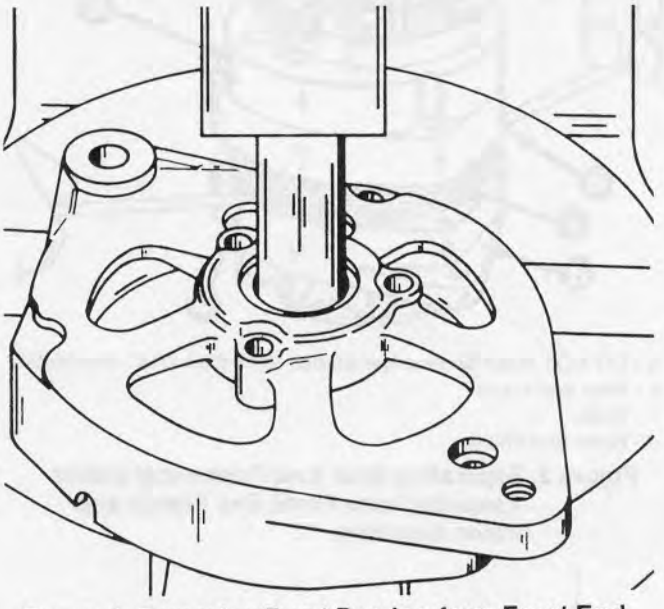


Figure 9. Removing Front Bearing from Front End Frame

12. Remove the (3) phillips head screws and lockwashers which secure the front bearing retaining plate. (Figure 8)
13. Remove front bearing from front end frame using an arbor press and a suitable size mandrel. (Figure 9) (Discard bearing.)
14. If rotor slip rings or rear bearing require replacement, entire rotor must be replaced. Parts cannot be purchased separately.

CLEANING and INSPECTION

1. Clean all parts with a clean, soft cloth. DO NOT use solvent, or electrical components may be damaged.
2. Inspect the following parts for wear and damage:
   a. Brush set - inspect for cracked porcelain casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than 1/4" (6mm) long.

b. Rotor - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
c. Rotor slip rings - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002" (.051 mm) maximum] and replace, if present.
d. Rotor shaft bearings - inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
e. Stator - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
f. Regulator - inspect leads for damaged insulation.
g. Front and rear end frames - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) MUST BE replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.
h. Fan - inspect for cracked or bent fins, broken welds (bi-rotational fan only) or worn mounting hole (from fan spinning on shaft).
i. Pulley - inspect pulley mounting bore end for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, grooves, pits, nicks or corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair, drive surfaces MUST BE perfectly true and smooth, or drive belt wear will be greatly accelerated.

COMPONENT TESTING

Rotor

1. Test rotor field circuit for opens, shorts or high resistance (Test 1, Figure 10), using an ohmmeter (set on Rx1 scale), as follows:

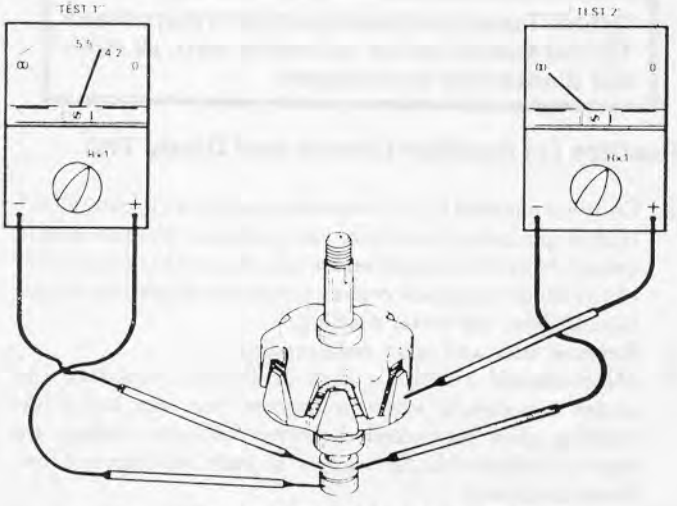


Figure 10. Testing Rotor Field Circuit

a. Connect one ohmmeter lead to each slip ring.
b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperature 70° - 80° F (21° - 26° C).
c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, or if reading is still high or infinite, replace complete rotor assembly.
d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, or if reading is still low, slip rings and rotor field windings are shorted, and complete rotor assembly must be replaced.

2. Test rotor field circuit for grounds (Test 2, Figure 10), using an ohmmeter (set on Rx1 scale) as follows:
a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.
b. Meter should indicate no continuity (meter should not move).
c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace motor assembly. If continuity is eliminated, replace slip rings.

IMPORTANT: If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, because of centrifugal force. Replace rotor, if all other electrical components test good.

Stator

IMPORTANT: Stator leads MUST BE disconnected from rectifier diodes and diode trio for this test.

1. Test stator for grounds (Test 1, Figure 11), using an ohmmeter (set on Rx1 scale) as follows:
a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.
b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.

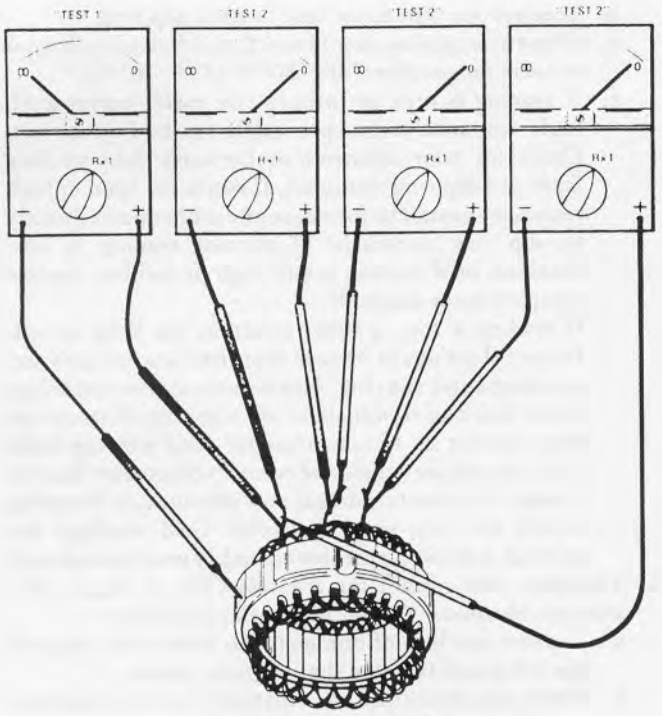


Figure 11. Testing Stator

2. Test for opens in stator, TEST 2 - Figure 11, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect ohmmeter between each pair of stator windings (3 different ways).
   b. Continuity should be present in all 3 cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.
3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sure sign of a short.

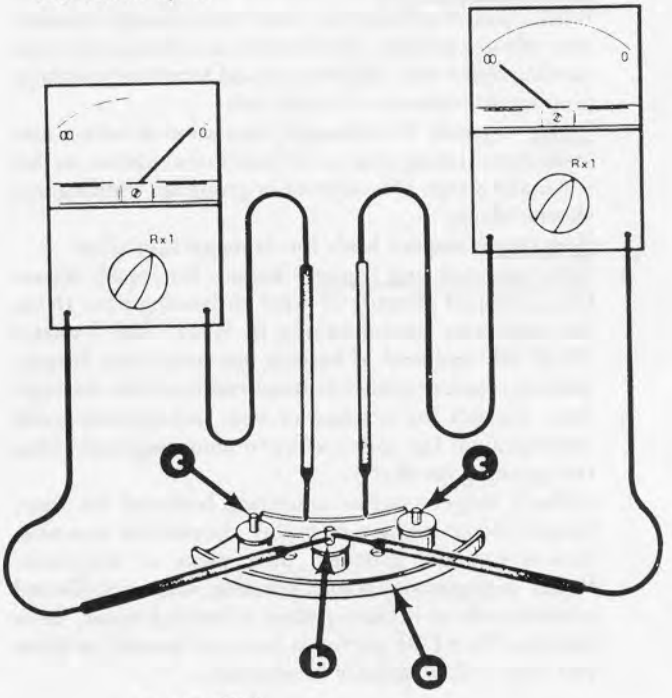
Negative (-) Rectifier Diodes

IMPORTANT: Rectifier diodes MUST BE disconnected from stator for this test.

⚠CAUTION

DO NOT use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

1. Connect one lead of on ohmmeter (set on Rx1 scale) to negative (-) rectifier diode heat sink and the other lead to one of the rectifier diode terminals. (Figure 12) Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink.
5. Replace complete rectifier set, if any one of the diodes is shorted or open.



a - Heat Sink
b - Diode Terminal
c - Test These 2 Diodes in Same Manner

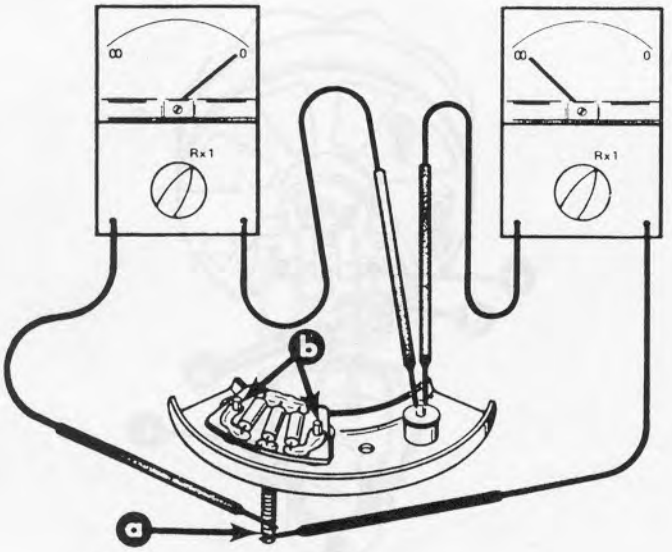
Figure 12. Testing Negative (-) Rectifier for Shorts or Opens

⚠CAUTION

DO NOT use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

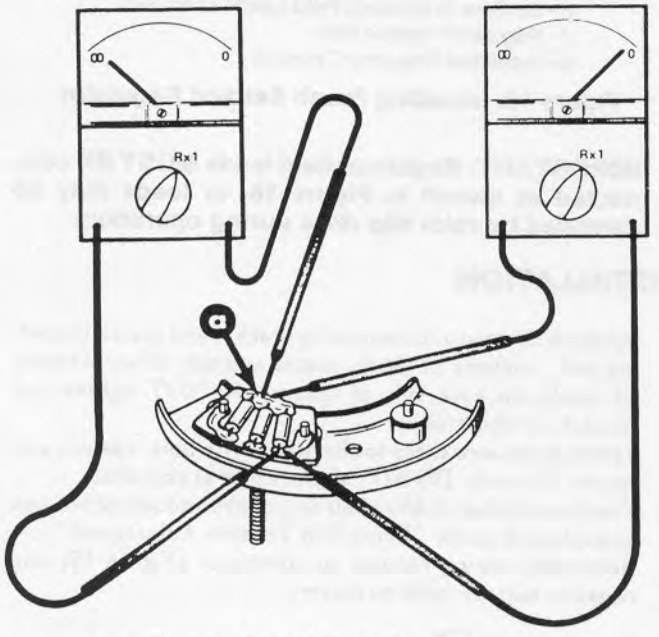
Positive (+) Rectifier Diodes and Diode Trio

1. Connect one lead of an ohmmeter (set on Rx1 scale) to ¼" stud on positive (+) rectifier heat sink and the other lead to one of the rectifier diode terminals. (Figure 13) (Note: Two of the diode terminals come up thru the diode trio circuit board.) Note the meter reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink.



a - Stud
b - Repeat Test between These Terminals and Stud

Figure 13. Testing Positive (+) Rectifier Diodes for Shorts or Opens



a - Common Side of Diode Trio Circuit Board

Figure 14. Testing Diode Trio for Shorts or Opens

5. Replace complete rectifier set, if any one of the diodes is shorted or open.
6. Connect one lead of an ohmmeter (set on Rx1 scale) to the common side on the diode trio circuit board and the other lead to the other side of one of the three (3) trio diodes. (Figure 14) Note the reading.
7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode trio is open. If both readings are low, diode Trio is shorted.
9. Repeat Steps 6-thru-8 for the other 2 diodes.
10. Replace positive (+) rectifier and diode trio assembly if any one of the dioeds is shorted or open.

Condenser

1. Using Magneto Analyzer and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd).
   b. Condenser Short or Leakage Test.
   c. Condenser Series Resistance Test.
2. Replace condenser, if test results are not within specifications.

REASSEMBLY

1. Install new front bearing into front end frame bearing bore using an arbor press. (Figure 15) If necessary, use a bearing driver that contacts outer race only.
2. Install front bearing retaining plate using 3 phillips head screws and lockwashers. (Figure 16)

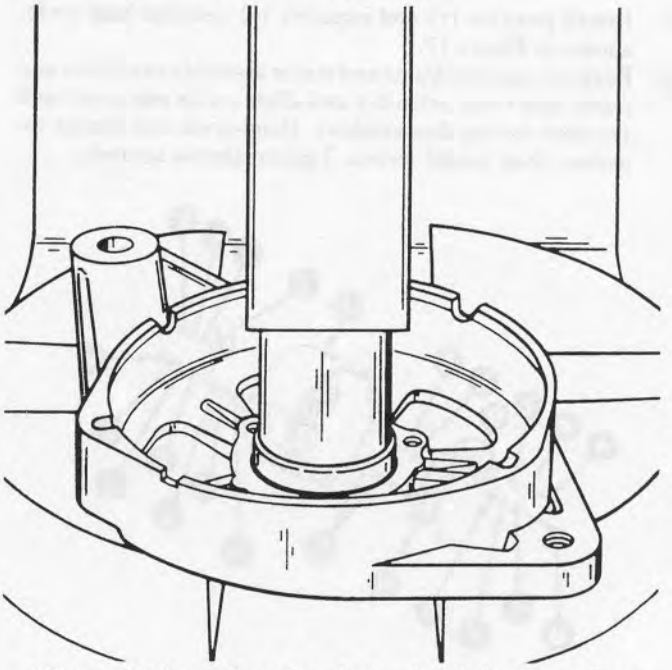
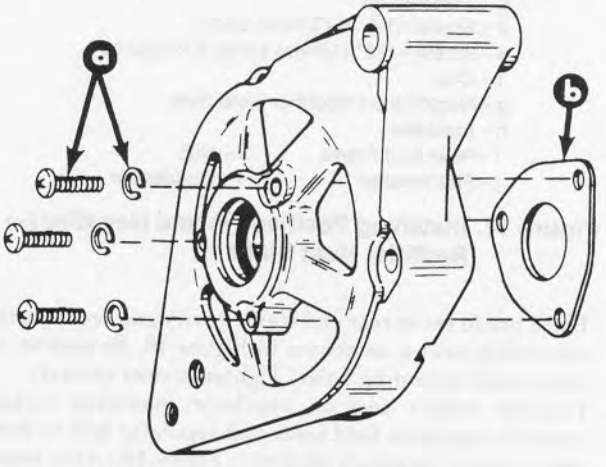


Figure 15. Installing Front Bearing into Front End Frame



a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

Figure 16. Installing Front Bearing Retaining Plate

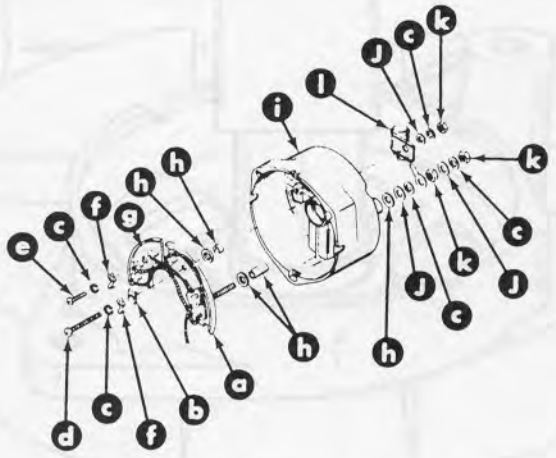
3. Slide front end frame over rotor.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when tightening pulley nut (in next step), or pole pieces may be distorted.

4. Slide fan spacer onto rotor shaft. Install fan, pulley, lockwasher and nut on shaft. Clamp pulley in a vise, using protective jaws or an old oversize V-belt to protect pulley (Figure 7), and torque nut to specifications. Tighten vise only enough to allow tightening of nut, as excessive tightening may distort pulley.

IMPORTANT: The insulating washers MUST BE installed as shown or damage to the alternator WILL result.

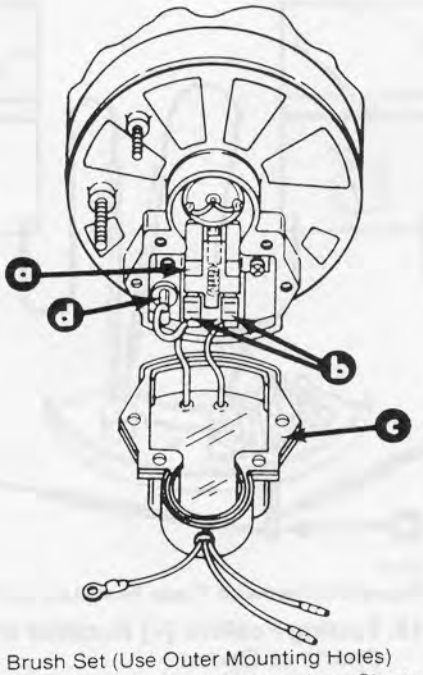
5. Install positive (+) and negative (-) rectifier heat sinks, shown in Figure 17.
6. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install screws. Tighten screws securely.



a - Positive (+) Rectifier Heat Sink
b - Rectangular Insulator
c - Lockwasher
d - Screw - 1-1/2" (38mm) Long
e - Screw - 1/2" (13mm) Long; 2 Required
f - Clip
g - Negative (-) Rectifier Heat Sink
h - Insulator
i - Rear End Frame
j - Flat Washer
k - Nut
l - Condenser

Figure 17. Installing Positive (+) and Negative (-) Rectifier Heat Sinks

7. Place brush set in rear end frame cavity and secure with 2 mounting screws, as shown in Figure 18. Be sure to use outer-most mounting holes. Tighten screws securely.
8. Position rubber seal on regulator mounting surface. Connect regulator field leads and regulator lead to brush and regulator terminals (shown in Figure 18.), then mount regulator with 4 screws. Connect ground terminal and secure with lockwashers and nuts. Tighten screws and nuts securely.



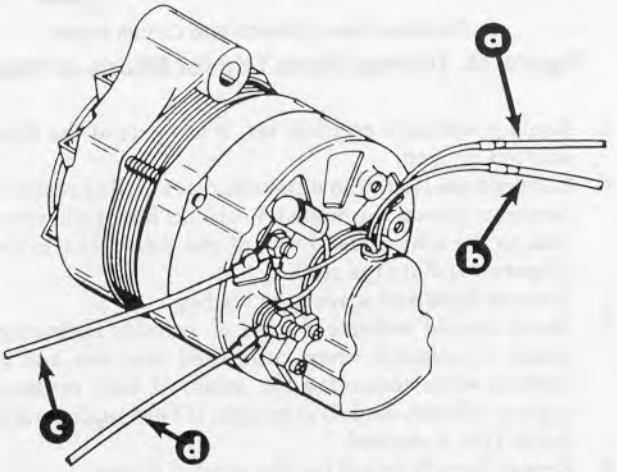
a - Brush Set (Use Outer Mounting Holes)
b - Be Sure to Connect Field Leads as Shown
c - Regulator Rubber Seal
d - Insulated Regulator Terminal

Figure 18. Installing Brush Set and Regulator

IMPORTANT: Regulator field leads MUST BE connected as shown in Figure 18, or leads may be damaged by rotor slip rings during operation.

INSTALLATION

1. Position alternator in mounting bracket and install mounting bolt, washers (if used), spacer and nut. Place washers (if used), on each side of spacer. DO NOT tighten nut securely at this time.
2. Fasten alternator brace to alternator with bolt, washers and spacer (if used). DO NOT tighten bolt at this time.
3. Position alternator drive belt on pulleys and adjust tension as explained under "Drive Belt Tension Adjustment".
4. Reconnect wiring harness to alternator (Figure 19) and negative battery cable to battery.



a - Excitation Lead (Purple)
b - Sensing Lead (Red/Purple)
c - Ground Lead (Black)
d - Output Lead (Orange)

Figure 19. Wiring Harness Connected to Alternator

470/485/488 CHARGING SYSTEM

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Hose Clamps	Securely	
Rotor	50 (68)	
Stator		45 (5)
Voltage Regulator (Bolts)	Securely	
Voltage Regulator (Nuts)	Securely	

TOOLS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-99750	Volt/Ohm Meter

KENT-MOORE SPECIAL TOOLS Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
J-21058-20	Rotor Installation Tool
J-6978-04	Rotor Removal Tool

TOOLS PURCHASED LOCALLY
Ammeter (0-50 Amps)

SEALANTS	
92-25711	Quicksilver Liquid Neoprene
92-32609	Quicksilver Loctite "A"

SPECIFICATIONS

Model	Amp Output (Max.)	Rotation
MCM/MIE 470, MCM 485/488	39	Bi-Rotational

DESCRIPTION

The electrical generating positon of this charging system is quite simple. It consists of six large permanent magnets (rotor), which are rotated by the crankshaft and move past a stationary iron lamination assembly wound with a single phase winding (stator).

The complexity of this charging system is in the regulation of this output. Since the permanent magnets are always turned "full on", the output of the winding is also always at full potential.

This differs from the automotive type where the output can easily be varied by controlling the strength of the rotating electromagnet. The regulator controls output by momentarily and completely disconnecting the output winding from the battery when the regulator senses that the battery is at its correct voltage. The disconnect periods are very short with frequency and duration dependent upon the needs of the battery. This disconnecting of the windings is done thru the use of a pair of silicon control rectifiers in the full wave rectifying bridge of the regulator. The regulators control of this on-off switching is programmed so that no electrical noise, output interruptions, or pulsing of the output current is detectable.

PRECAUTIONS

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the charging system.
2. DO NOT short across or ground any of the terminals on the regulator, except as specifically instructed in the "Troubleshooting Tests".
3. NEVER disconnect the regulator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (-) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and the positve (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

PERIODIC MAINTENANCE

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connections.
2. Check wiring for frayed or worn insulation.

REMOVAL/INSTALLATION

For removal and installation instructions for removing the rotor and stator assembly refer to "Section 6 Part B". To adjust the power steering belt (if equipped) refer to "Drive Belt Tension Adjustment" (This section).

TROUBLESHOOTING TESTS (ON ENGINE)

⚠WARNING

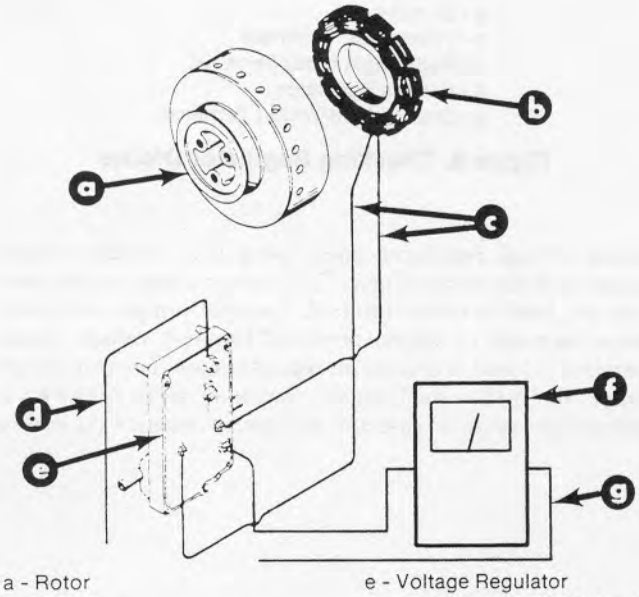
When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of a fire.**
- **Before connecting or disconnecting any electrical connection, battery cables MUST BE REMOVED from battery to prevent possible personal injury or damage to equipment.**

A. The charging system may be connected to one or more batteries during these tests, however, these batteries must not be connected to any other charging source.
B. Check that all connections are tight prior to starting tests. Insure that the battery posts and terminals are clean and making good contact. Verify with test equipment that wiring harnesses are not at fault.
C. Examine the pins and sockets of the engine harness connector for burned, loose or dirty connections. Using a knife blade, spread the slot (in the male pins of this connector) slightly to insure good contact.
D. Make sure alternator rotor is magnetized.

IMPORTANT: Temporarily install ammeter in series with the orange (red/white) output lead from the regulator. This meter is required only for these tests, following:

CONSTANT HIGH OUTPUT (Figure 1)



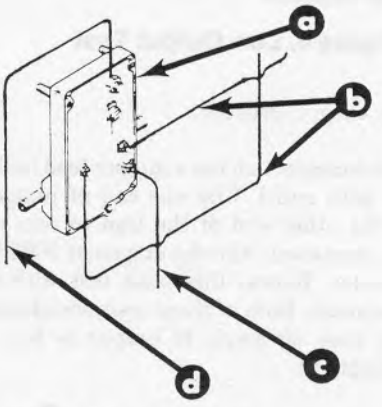
a - Rotor
b - Stator
c - Stator Wires - Yellow/Red
d - Sensing Wire - Red/Purple (Red)
e - Voltage Regulator
f - Test Ammeter (0-50 Amps)
g - Output Wire - Orange (Red/White)

Figure 1. Constant High Output Test

1. Remove one yellow-red wire from its regulator terminal and tape back temporarily. Run engine at 1000 RPM. Any output current indicates a stator short to ground.
2. Reconnect the yellow-red lead and repeat test with the other yellow-red lead.
3. If there is no output with either yellow-red lead in the above test, the regulator is bad.

NO OUTPUT (Figures 2 and 3)

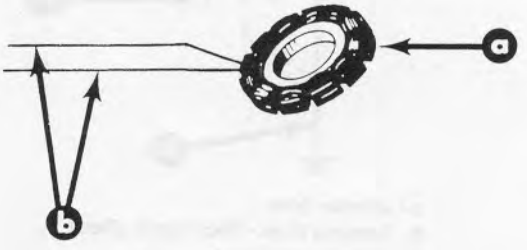
1. Remove the 2 yellow/red and the orange (red/white) leads from the regulator.
2. Check the resistance between the regulator case and either yellow/red stud. A near zero reading from either stud to the case indicates a bad regulator.



a - Voltage Regulator
b - Stator Wires - Yellow/Red Disconnect
c - Output Wire - Orange (Red/White) Disconnect
d - Sensing Wire - Red/Purple (Red)

Figure 2. No Output Test (Regulator)

3. Check the resistance between the yellow/red leads. Resistance greater than 1 ohm indicates a bad stator. (Figure 3)

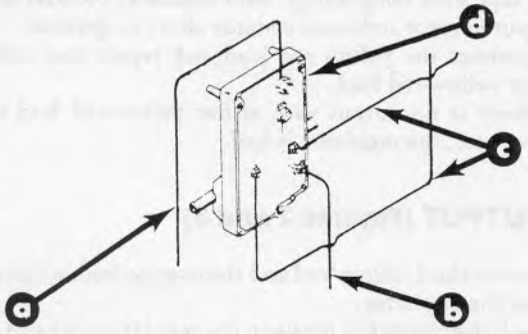


a - Stator
b - Stator Wires - Yellow/Red

Figure 3. No Output Test (Stator)

If Steps 2 and 3 tests show both parts to be good, proceed.

4. With all leads on the regulator, except the sense lead, run the engine at 1000 RPM and observe ammeter. Any charging rrent indicates a low voltage set point - replace regulator. (Figure 4)

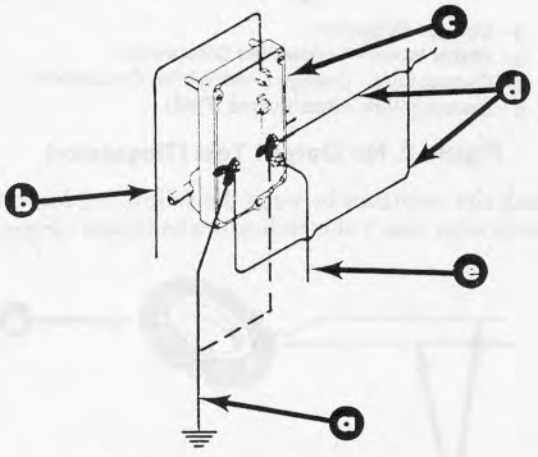


a - Sensing Wire - Red/Purple (Red) Disconnect
b - Output Wire - Orange (Red/White)
c - Stator Wires - Yellow/Red
d - Voltage Regulator

Figure 4. Low Output Test

If there isn't any output, proceed.

5. With all leads reconnected, use a jumper lead (with "alligator clips" at both ends). Clip one end of jumper lead to ground and the other end of the lead to one yellow-red terminal (on regulator). Run the engine at 1000 RPM and observe ammeter. Repeat this same test with the other yellow-red terminal. Both of these tests should indicate an output of at least 10 amps. If output is less - replace regulator. (Fiugre 5)



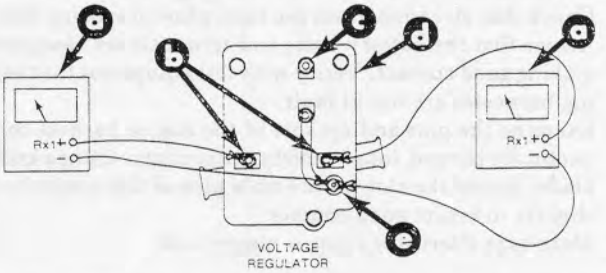
a - Jumper Wire
b - Sensing Wire - Red/Purple (Red)
c - Voltage Regulator
d - Stator Wires - Yellow/Red
e - Output Wire - Orange (Red/White)

Figure 5. Low Output Test

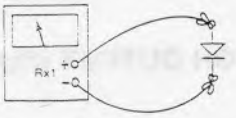
IMPORTANT: Excessive resistance in the ammeter circuit can cause voltage regulator damage on MerCruiser 470/485 engines. To prevent this possibility, a Voltage Regulator kit (99502A8), which eliminates the ammeter circuit, has been released. The kit includes a voltage regulator, jumper wire and installation instructions. Install this kit on any MerCruiser 470 (Serial No. 4625580 and above) or 485 engine (originally equipped with an ammeter) with which recurring voltage regulator failures have been experienced. Refer to "Section 3, Part E" for installation instructions.

VOLTAGE REGULATOR TEST

Disconnect both battery cables from battery and remove regulator from engine. Check regulator diodes (Figure 6) by connecting positive (+) ohmmeter lead to one stator terminal (yellow/red) and negative (-) ohmmeter lead to output (orange or red/white) terminal. Meter MUST show conduction. Reverse ohmmeter leads. Meter MUST NOT show conduction. Repeat test for other stator (yellow/red) terminal.



NOTE: Positive lead of ohmmeter shows conduction with a diode, as shown below.

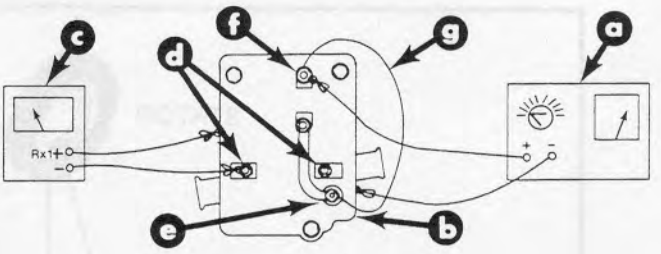


a - Ohmmeter
b - Yellow/Red Terminals
c - Red/Purple (Red) Terminal
d - Voltage Regulator
e - Orange (Red/White) Terminal

Figure 6. Checking Regulator Diodes

Check voltage regulation point using D.C. variable voltage supply and ohmmeter (Figure 7). Connect voltage supply positive (+) lead to sense terminal. Connect jumper wire form sense terminal to output terminal. Connect voltage supply negative (-) lead to ground on regulator case. Turn on voltage supply to 16-18 volts. Connect ohmmeter positive (+) lead to ground on regulator case and ohmmeter negative (-) lead to

one stator yellow/red terminal. Ohmmeter MUST NOT show conduction. If meter shows conduction, momentarily disconnect and reconnect it. If meter still shows conduction, voltage regulator is bad (regulation point too high) and must be replaced. If meter did not show conduction, slowly reduce voltage supply setting while observing ohmmeter. Meter MUST go into conduction at some voltage between 15 volts and 13.5 volts. If meter does not show conduction when supply voltage is reduced to between 15 and 13.5 volts, voltage regulator is bad (regulation point too low) and must be replaced. Repeat test for other stator yellow/red terminal.



a - D.C. Variable Voltage Supply
b - Voltage Regulator
c - Ohmmeter
d - Yellow/Red Terminal
e - Output Terminal
f - Sense Terminal
g - Jumper Wire

Figure 7. Checking Voltage Regulator Point

BATTERY ISOLATORS

DUAL BATTERY CHARGING SYSTEMS USING A BATTERY ISOLATOR

Battery isolators allow the addition of an auxiliary (second) battery to the MerCruiser electrical system. the auxiliary battery is primarily used as a power source for various accessories installed on the boat. The battery isolator will allow the alternator to charge both the cranking and auxiliary batteries at the same time while preventing accessories, connected to the auxiliary battery, from drawing power from the cranking battery.

Mercury Marine does not manufacture any battery isolator systems. Battery isolators must be bought from an outside manufacturer. Mercury Marine suggests following the manufacturers instruction carefully.

IMPORTANT: Alternators used on MerCruiser engines ARE NOT equipped with an isolation diode.

⚠CAUTION

Follow battery isolator manufacturer's instructions for wire gauge. Battery isolator installation must conform to BIA Low Voltage Wiring Standard No. 125-79.

MerCruiser engines that meet the following requirements can use a battery isolator.

MCM/MIE 470/MCM 485/488

1. Engines equipped with 86255A2 or 99502A9 Water Cooled Voltage Regulator.
2. MCM/MIE 470 (Serial No. 4625580 thru 5120655) with 77305A2 Water Cooled Voltage Regulator, must have a new 99502A8 Regulator installed.
3. Figures 1, 2, 3 or 4.

ALL OTHER MODELS

1. All engines equipped with a 3-wire belt driven alternator.
2. We recommend 1-wire Delco alternators be replaced with a 3-wire belt driven alternator (78403A2) before installing a battery isolator.
3. Figures 5 or 6.

Following are suggested wiring installations for MerCruiser engines.

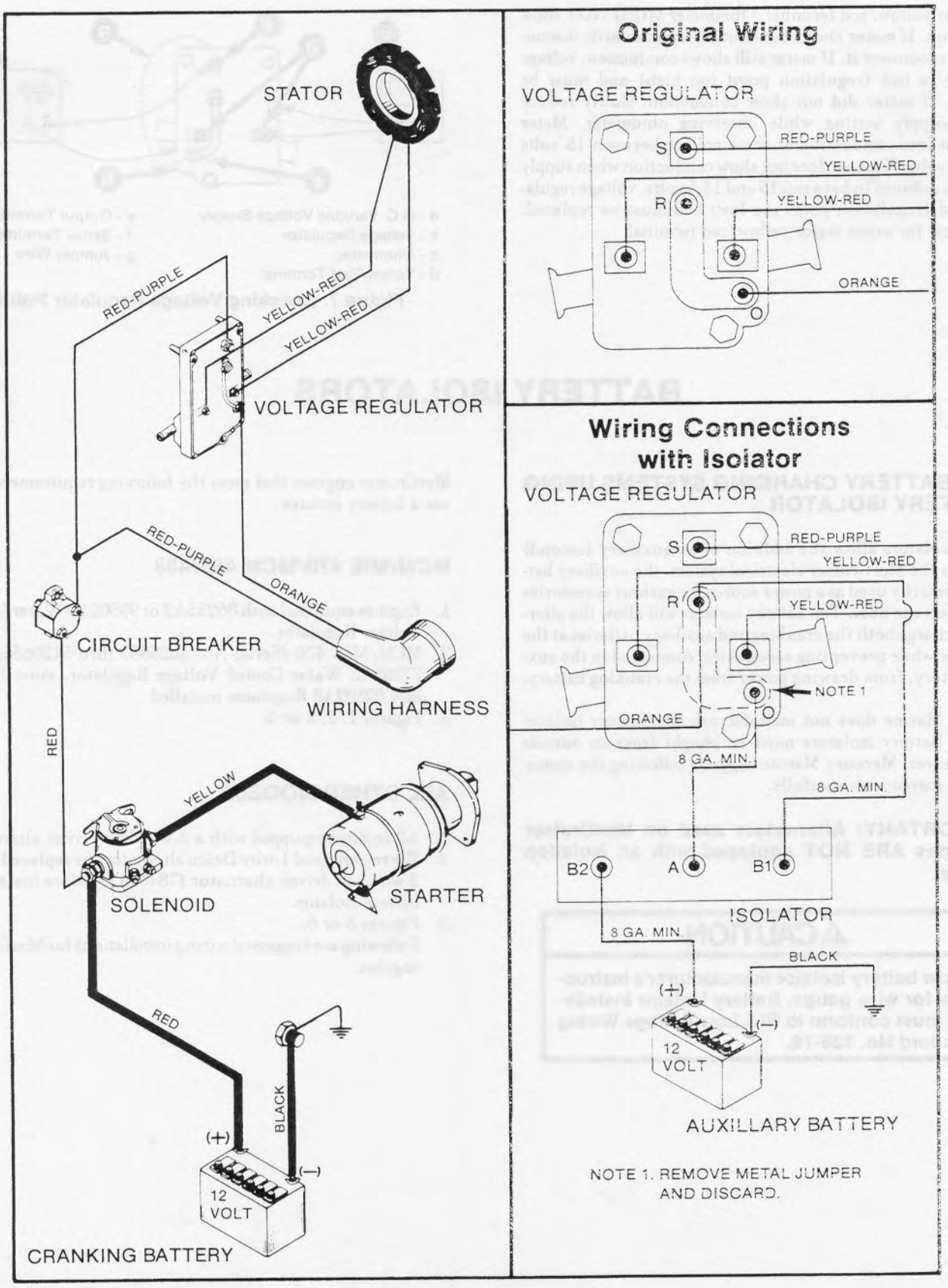


Figure 1. MCM/MIE 470 and MCM 485 with Ammeter (Prestolite Starter Motor)

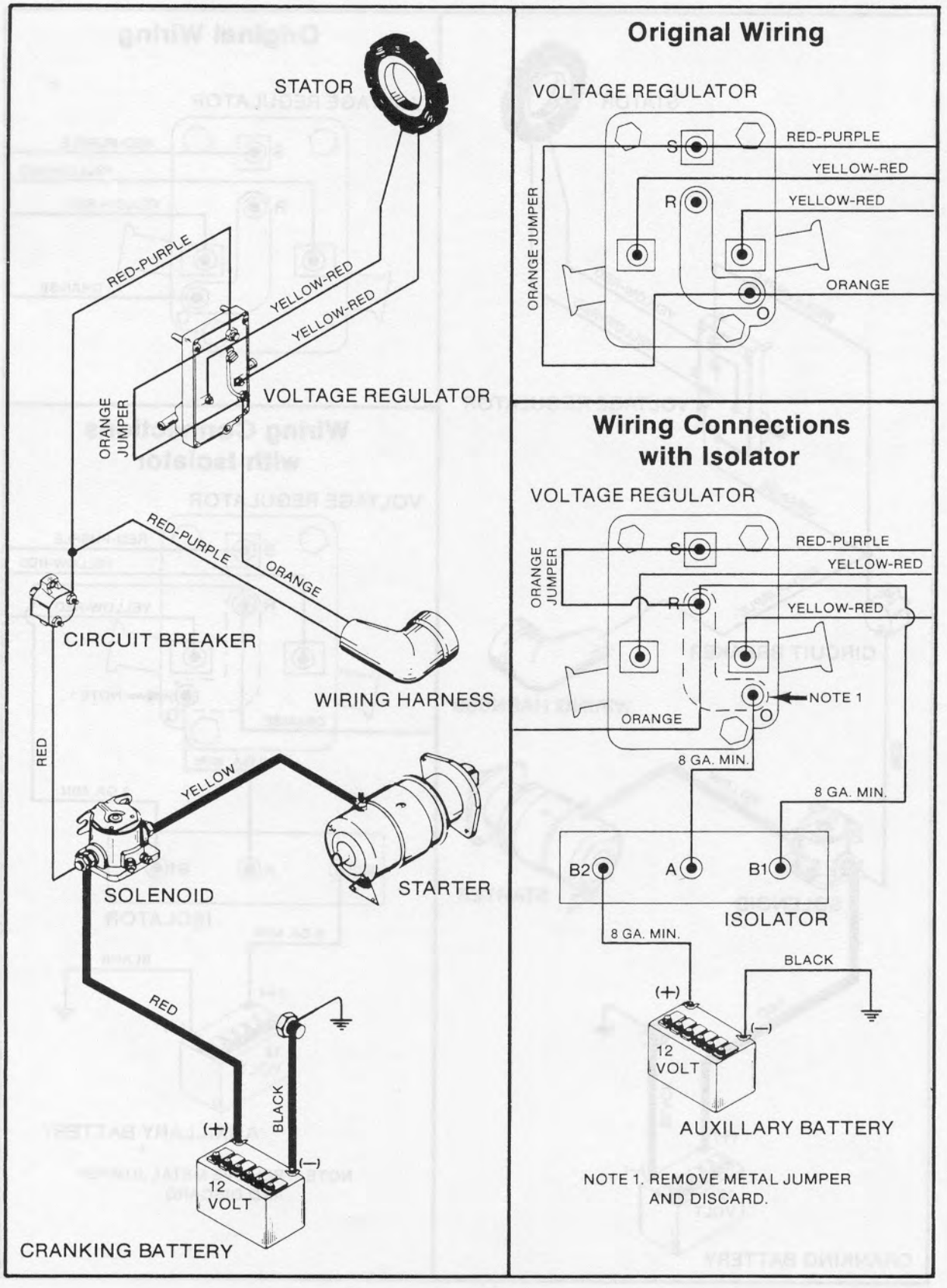


Figure 2. MCM/MIE 470 and MCM 485 with Voltmeter and Ammeter By-Pass Jumper Wire (Prestolite Starter Motor)

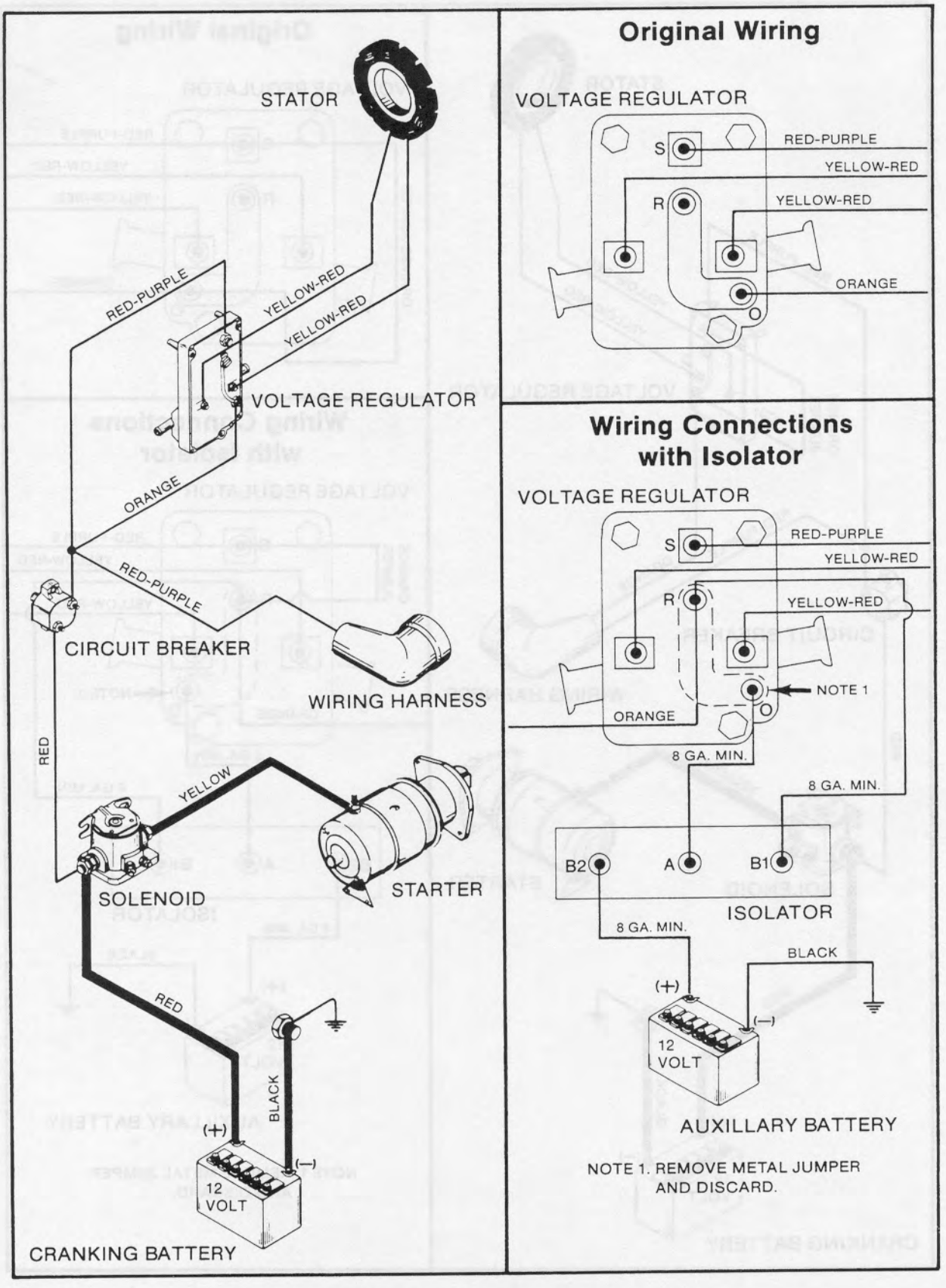


Figure 3. MCM 470/485 with Engine Wiring Harness Wired for Voltmeter (Prestolite Starter Motor)

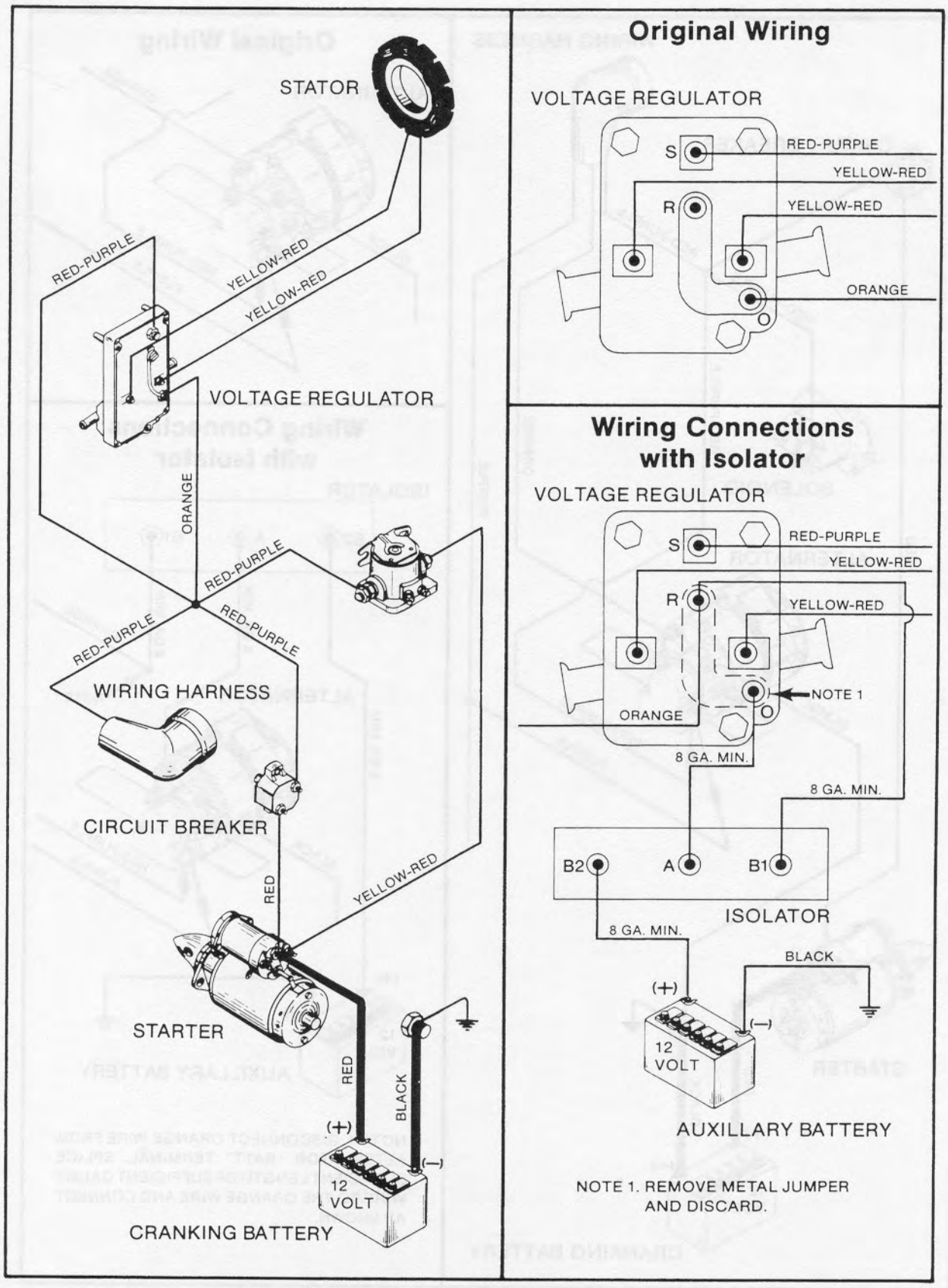


Figure 4. MCM 470R/488R with Engine Wiring Harness Wired for Voltmeter (Delco Remy Starter Motor)

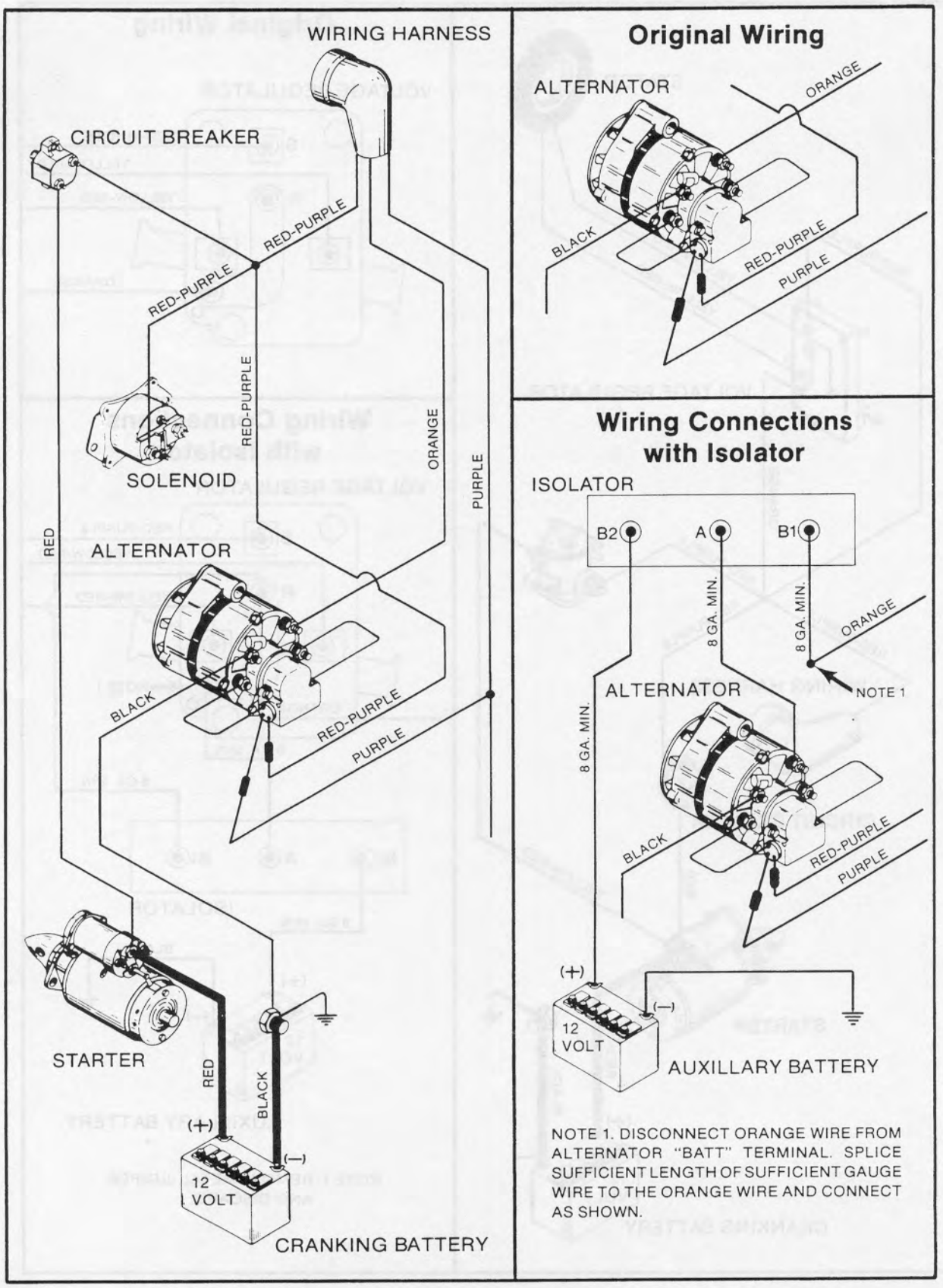


Figure 5. 3-Wire Belt Driven Alternator with Ammeter Circuit (Typical Wiring Shown)

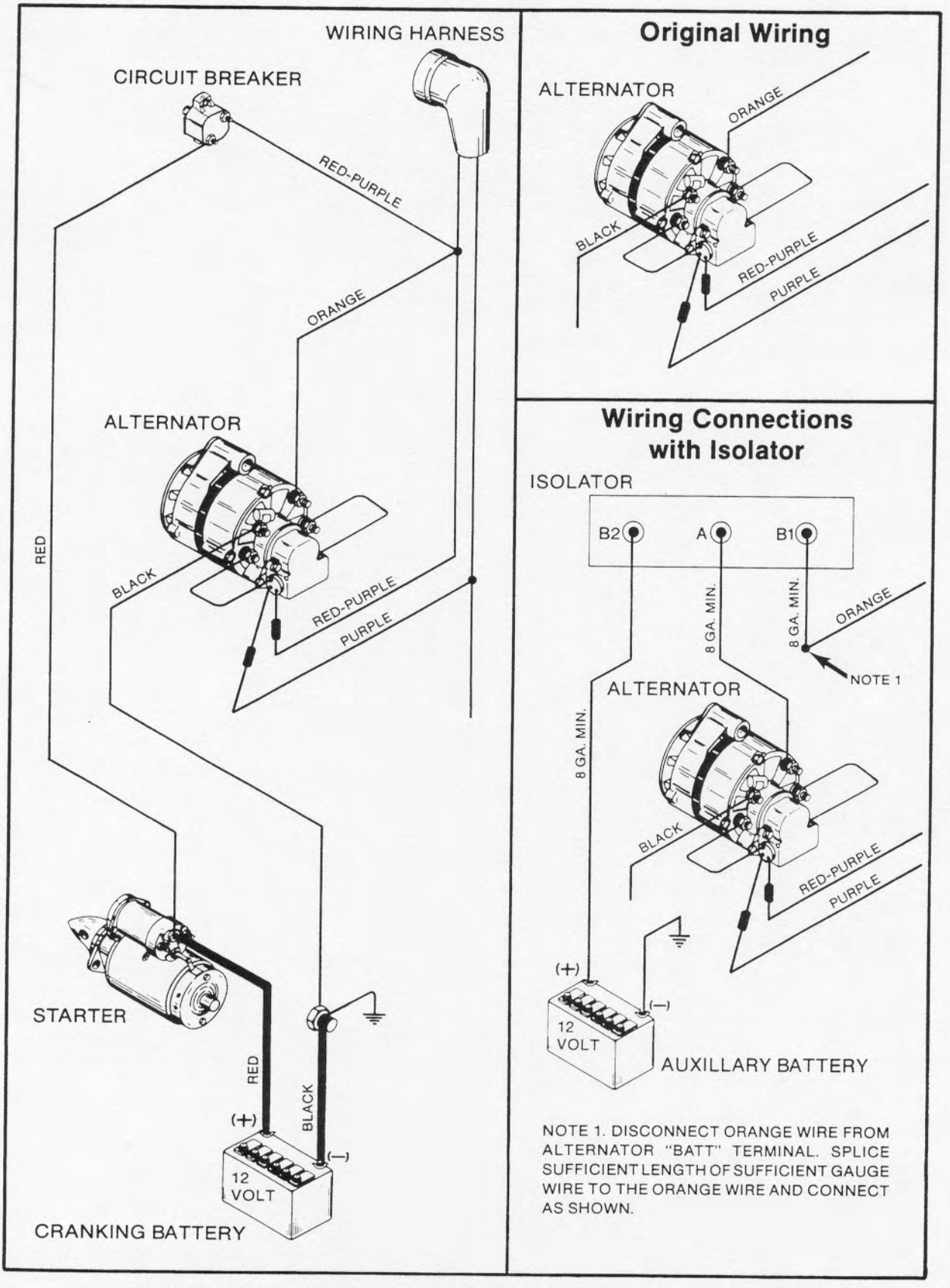
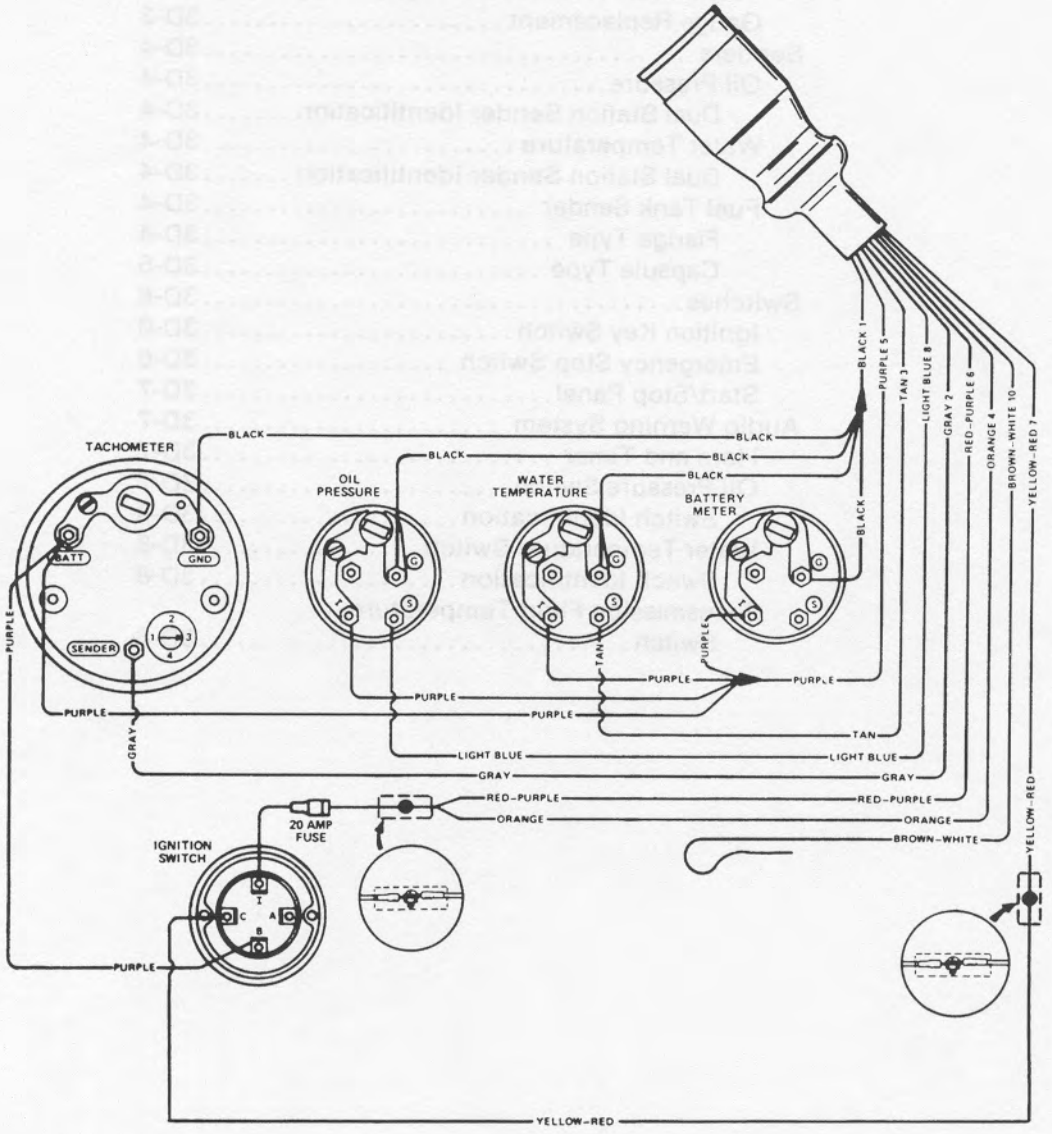


Figure 6. 3-Wire Belt Driven Alternator with Voltmeter Circuit (Typical Wiring Shown)

Figure 5. 3-Wire Belt Driven Alternator with Voltmeter Circuit (Typical Wiring Shown)

SECTION 3 - ELECTRICAL SYSTEM

PART D - INSTRUMENTATION



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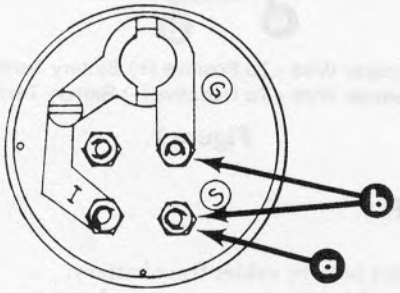
GAUGES

OIL, FUEL and TEMPERATURE

IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

1. Turn ignition switch to "Off".
2. Remove wire from terminal "S". (Figure 1)
3. Turn ignition switch to "Run". Gauges must be at "A" position. (Figure 2)



a - Remove Wire
b - Jumper Wire

Figure 1. Testing Gauge

4. Turn ignition switch "Off".
5. Connect jumper wire from terminal "G" to terminal "S".
6. Turn ignition switch to "Run". Indicator needle must read at "B" position. (Figure 3)
7. Replace gauge if needle was not in positions as shown in Figure 2 and 3.

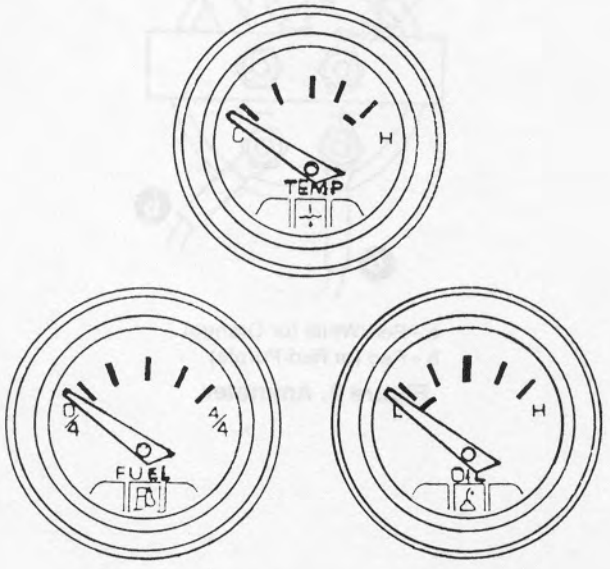


Figure 2. Position "A"

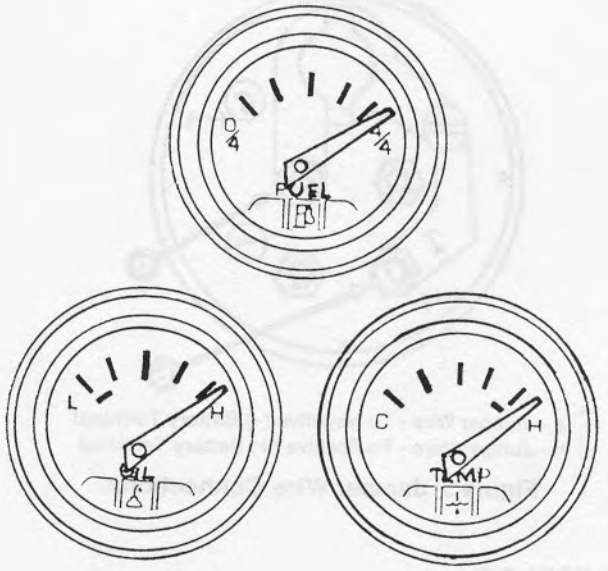


Figure 3. Position "B"

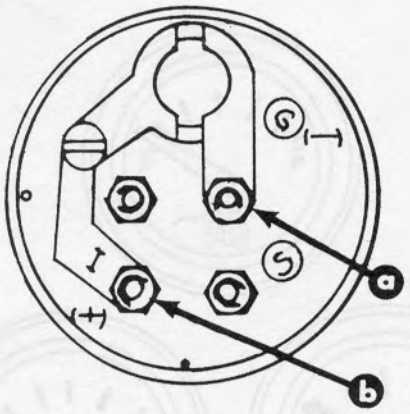
BATTERY GAUGE

IMPORTANT: Fully charged battery must be used.

1. Turn ignition key to "Run" position.
2. Gauge reading should be approximately what battery voltage is. (Figure 4) Shut key "Off".

Figure 4. Battery Gauge

3. If gauge is out of dash, connect jumper wires as shown in Figure 5.

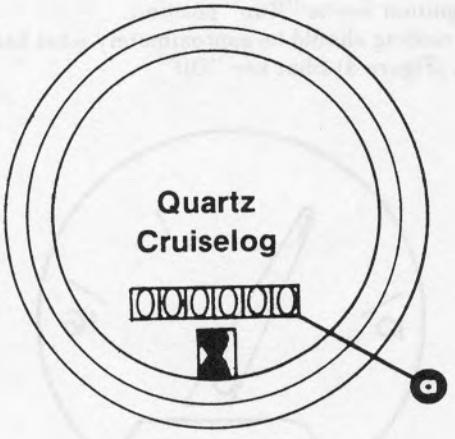


a - Jumper Wire - To Negative (-) Battery Terminal
b - Jumper Wire - To Positive (+) Battery Terminal

Figure 5. Jumper Wire Connections

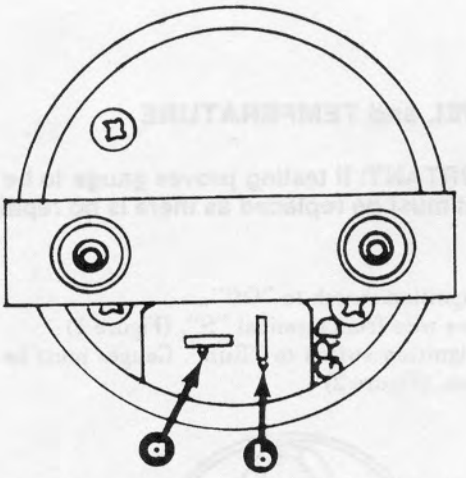
CRUISELOG

1. Turn ignition key to "Run" position.
2. If gauge is good, run indicator will be turning. (Figure 6) Turn key to "Off" position.
3. If gauge is out of dash, connect jumper wires as shown in Figure 7.



a - Run Indicator

Figure 6. Cruiselog



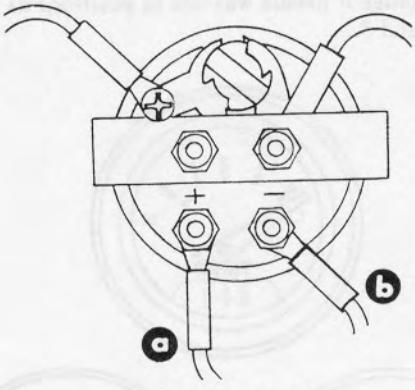
a - Jumper Wire - To Positive (+) Battery Terminal
b - Jumper Wire - To Negative (-) Battery Terminal

Figure 7.

AMMETER

1. Disconnect battery cables from battery.
2. Remove red/white (or orange) and red (or red/purple) wires from back of ammeter gauge. (Figure 8)
3. Connect positive (+) lead of service ammeter to red/white (or orange) wire (removed from gauge) and connect negative (-) lead of service ammeter to red wire (or red/purple) (removed from gauge).

IMPORTANT: DO NOT allow wires to come in contact with metal or other wires.



a - Red/White (or Orange)
b - Red (or Red/Purple)

Figure 8. Ammeter

4. Connect battery cables to battery. Ground engine high tension coil wire to engine block. Crank engine over approximately 10 seconds (to remove battery surface charge), then reconnect coil wire, start engine and run at approximately 3000 RPM while observing service ammeter. Ammeter should be registering alternator output. If charging system is in working condition, and service ammeter registers but ammeter gauge did not register, gauge is defective.

VACUUM GAUGE

1. Disconnect vacuum hose from engine. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 RPM. Reconnect vacuum hose and compare vacuum gauge readings (at specified RPM) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

SPEEDOMETER

IMPORTANT: When testing speedometer gauge for accuracy, air pressure that is used for test must be regulated to specified PSI. DO NOT apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Light tapping of pressure gauge is required during accuracy check.
2. If gauge readings are not within specifications, gauge is defective.

Air Pressure Gauge PSI	Speedometer Gauge MPH
5.3	20 ± 1 (32 km/hr ± 1.6)
27.8	45 ± 1 (72 km/hr ± 1.6)

TACHOMETER

1. Connect a service tachometer to engine and compare readings.
2. Replace if not within specifications.

TACHOMETER TYPE	ALLOWABLE RANGE
6000 RPM	± 150 RPM
8000 RPM	± 200 RPM

GAUGE REPLACEMENT

1. Disconnect battery cables from battery.
2. Remove wires from back of gauge.
3. **Vacuum and speedometer:** Remove hose.
4. Disconnect light socket.
5. Remove holding strap and remove gauge.
6. Position gauge assembly in appropriate mounting hole.
7. Install holding strap and nuts. Tighten nuts evenly and securely.

IMPORTANT: DO NOT distort case or bracket by over-tightening.

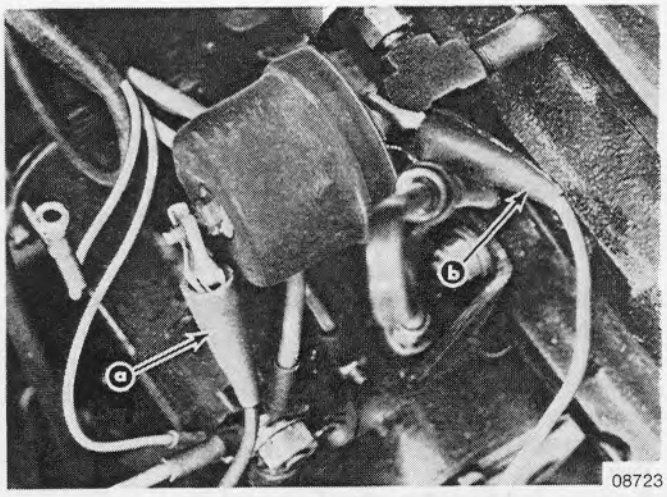
8. Connect ground (black) wire to ground terminal, if gauge is not mounted in metal panel.
9. Connect other wires to gauge as shown in "Section 3, Part F".
10. **Vacuum and Speedometer:** Connect hose.
11. Install gauge light socket.
12. Coat all terminals with Liquid Neoprene.
13. Reconnect battery cables to battery.

SENDERS

OIL PRESSURE

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to "Troubleshooting" section.

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:



a - Positive Lead
b - Negative Lead

Figure 1. Oil Pressure

Oil Pressure (Lbs./Sq. In.)	Ohms Reading	
	Single	Dual
0	227-257	113.5-128.5
20	142-162.5	71-81.3
40	91.7-113.6	45.9-56.8
80	9-49	11-24.5

Dual Station Sender Identification

Sender will have 353-AM stamped on hex of sender.

WATER TEMPERATURE

There is no accurate test that can be done without special equipment. Install new sender.

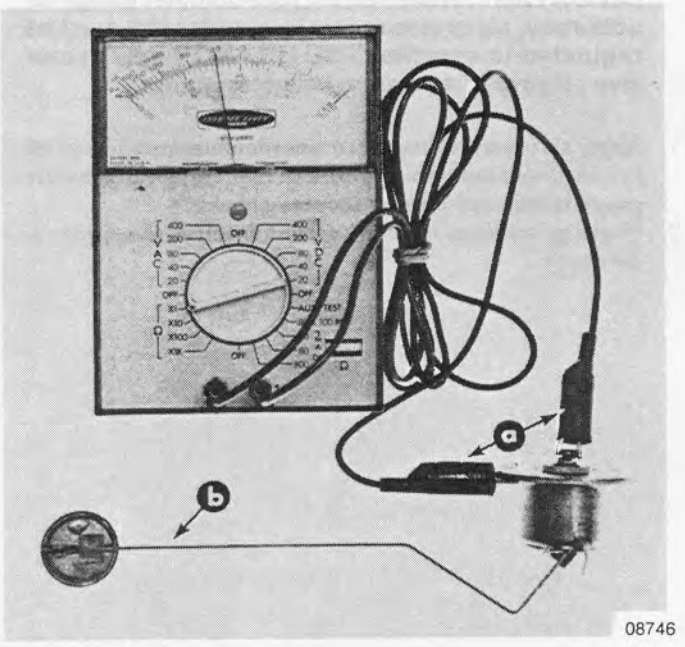
Dual Station Sender Identification

Sender will have 334-L stamped on hex of sender for 470, 485 and 488 engines. All other engines use sender with 362-BC stamped on hex.

FUEL TANK SENDER

Flange Type (Figures 2 and 3)

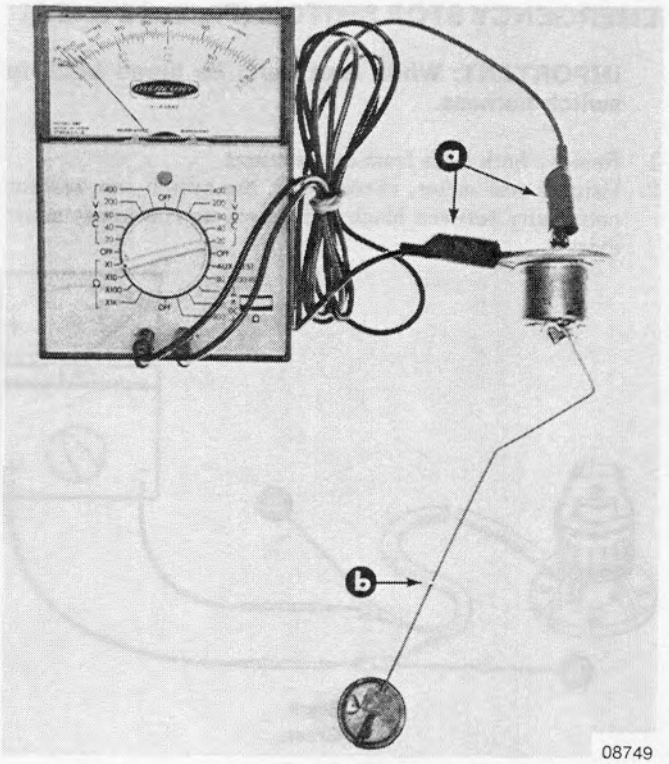
1. Disconnect wire from terminal on sending unit and ground wire from sending unit mounting screw.
2. Remove sending unit from fuel tank.
3. Connect ohms meter between sending unit terminal and sending unit housing.
4. With float arm in "full" position (arm horizontal), ohmmeter should read 30 ohms (± 5 ohms).



a - Ohmmeter Leads
b - Float Arm Horizontal

Figure 2. Arm Horizontal

5. With float arm in "empty" position (arm vertical) meter should read 240 ohms (± 5 ohms). Sender is defective if not within specifications.

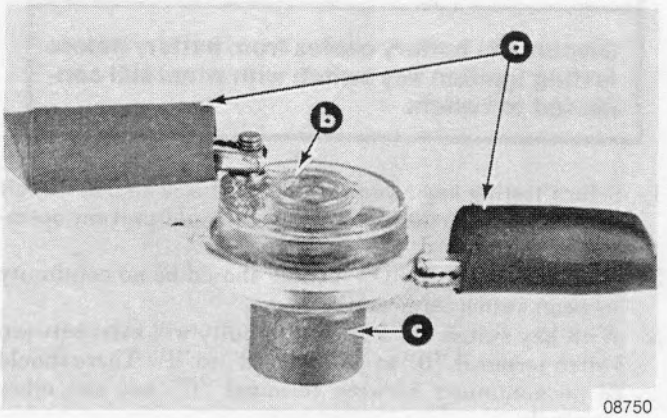


a - Ohmmeter Leads
b - Float Arm Vertical

Figure 3. Arm Vertical

Capsule Type (Figure 4)

1. Disconnect wire from termianl on fuel tank capsule.
2. Remove 2 screws and remove capsule assembly.
3. Place a magnet under fuel capsule.
4. Connect ohmmeter between fuel capsule terminal and metal portion of capsule housing.



a - Ohmmeter Leads
b - Capsule
c - Magnet

Figure 4. Ohmmeter and Magnet

5. Turn magnet counterclockwise until fuel capsule indicator reads empty. Ohmmeter should read 240 ohms (± 5 ohms).
6. Turn magnet clockwise until fuel capsule indicator reads "Full". Ohmmeter should read 30 ohms (± 5 ohms). Fuel capsule is defective if not within specifications.

SWITCHES

IGNITION KEY SWITCH (Figure 1)

⚠WARNING

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Before testing key switch, check all fuses and/or circuit breakers in electrical circuit which could prevent operation of starter.
2. With key switch in "Off", there should be no continuity between switch terminals.
3. With key switch in "Run", continuity will exist between switch terminal "B" to "A" and "B" to "I". There should be no continuity between terminal "C" and any other terminals.
4. With key switch in "Start", continuity will exist between terminal "B" to "A", "B"to "I" and "B" to "C".
5. If ignition key switch tests bad, unsolder wire connections and remove switch. Test switch again, as in Steps 2-thru-5, preceding. If switch tests good, wiring in harness is bad. There should be no continuity between any harness wires with key switch removed.

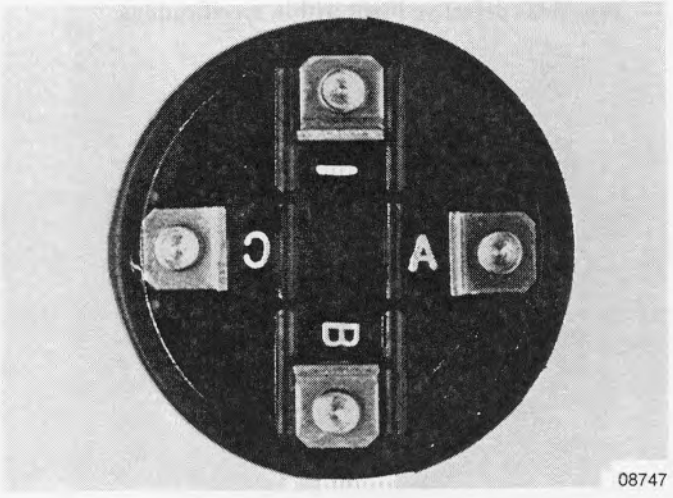
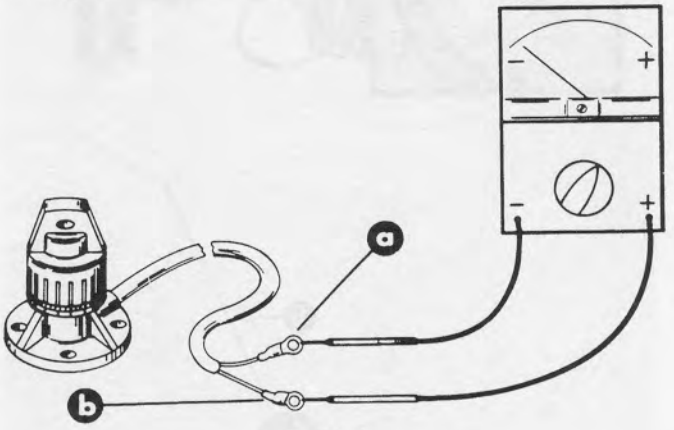


Figure 1. Switch Terminal Identification

EMERGENCY STOP SWITCH (Figures 2 and 3)

IMPORTANT: White lead must be taped back to switch harness.

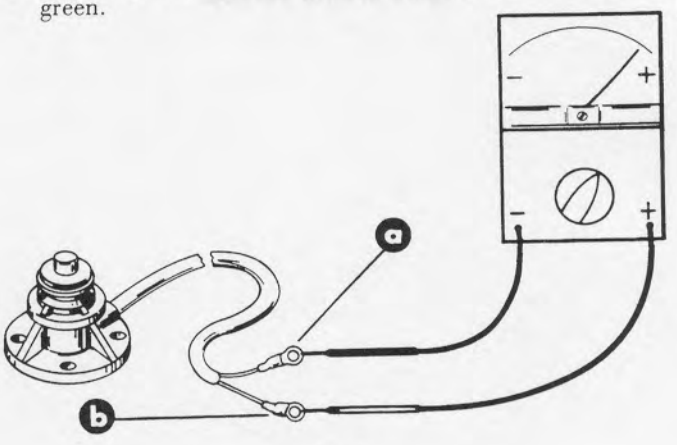
1. Remove both leads from connections.
2. Using a test meter, check (with the switch cap on) for continuity between black and green, no continuity must exist.



a - Black
b - Green

Figure 2.

3. With cap off, continuity must exist between black and green.



a - Black
b - Green

Figure 3.

START/STOP PANEL (Figure 4)

⚠WARNING

Disconnect battery leads at battery before testing.

1. Disconnect battery leads.
2. Check for continuity between the terminals on the start switch with a continuity meter.
3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the open (not depressed) state, replace panel button.

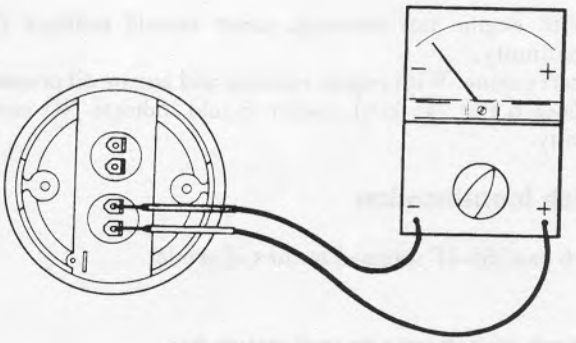
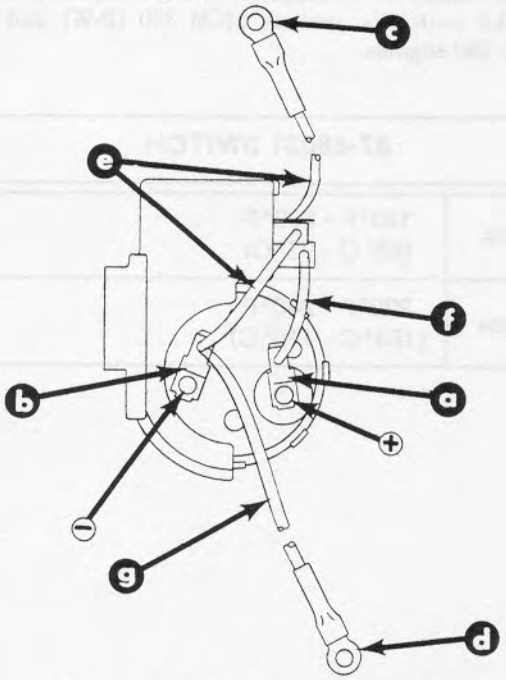


Figure 4.

AUDIO WARNING SYSTEM

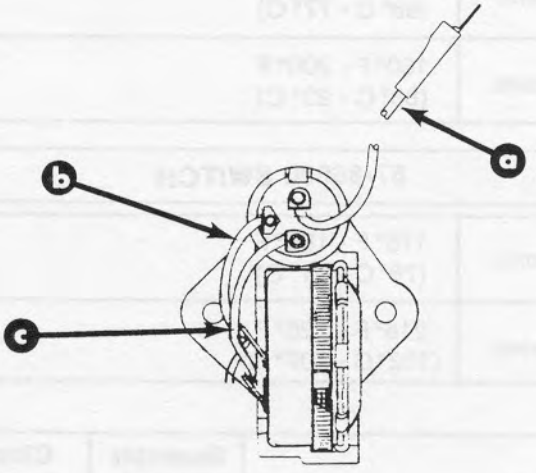
HORN AND TIMER

1. Turn key to "Run" position (engine off).
2. Wait 7 to 14 seconds for horn to sound.
3. If horn does not sound:
   a. Connect jumper wires as shown in Figure 1.
   b. If horn does not sound, replace it.
4. If horn worked in step 3:
   a. Connect jumper wires as shown in Figure 1.
   b. Repeat step 2.
   c. If horn sounds, problem is in tan/blue wire back to engine or switches on engine.



a - Jumper Wire to 12-V (+) — STEP 3
b - Jumper Wire to Ground (-) — STEP 3
c - Jumper Wire to 12-V (+) — STEP 4
d - Jumper Wire to Ground (-) — STEP 4
e - Purple Wire
f - Red Wire
g - Tan/Blue Wire

Figure 1. Testing Horn and Timer



a - Purple Wire
b - Purple Jumper Wire
c - Red Jumper Wire

Figure 2. Timer Wiring

OIL PRESSURE SWITCH (Figure 3)

Refer to "Section 3, Part E" for switch locations. Switch is normally closed.

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex.

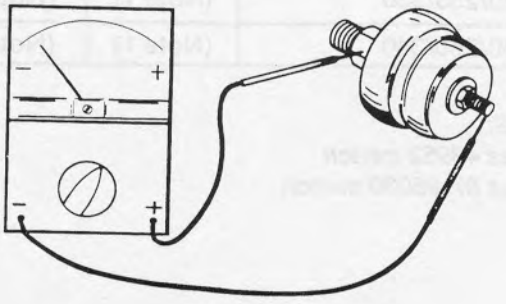


Figure 3.

3. With engine not running, meter should indicate full continuity.
4. Start engine. With engine running and engine oil pressure above 6 PSI (41 kPa), meter should indicate NO continuity.

Switch Identification

Switch has 364-AF stamped on hex of sender.

WATER TEMPERATURE SWITCH

Refer to "Section 3, Part E" for switch locations. Switch is normally open.

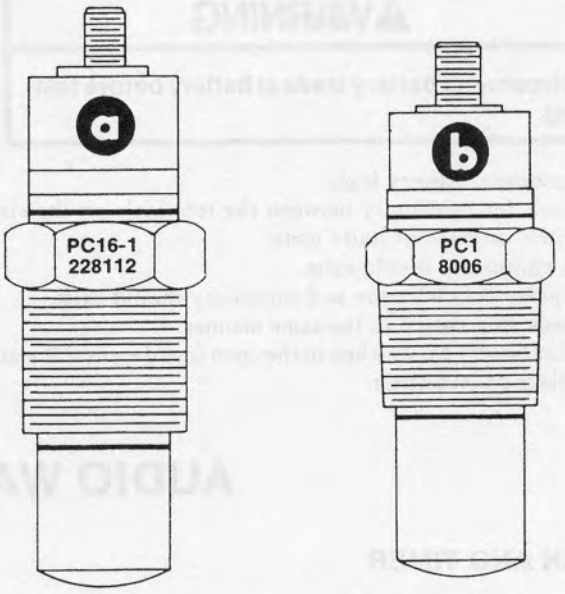
48952 SWITCH	
Opens	150° F - 170° F (66° C - 77° C)
Closes	190° F - 200° F (88° C - 93° C)

87-86080 SWITCH	
Opens	175° F - 195° F (79° C - 91° C)
Closes	215° F - 225° F (102° C - 107° C)

Model	Seawater Cooled Engine	Closed Cooled Engine
MCM 120/140/165	(Note 1)	(Note 1)
MCM/MIE 470 MCM 485/488		(Note 2)
MCM 898/228/260	(Note 1)	(Note 1)
MCM 898R/228R/260R	(Note 1)	(Note 1)
MCM 330	(Note 1)	
MCM 330 (B-W)	(Note 1)	(Note 2)
MCM 370	(Note 1)	
MIE 220/255/330	(Note 1)	(Note 1)
MIE 230/260/340	(Note 1)	(Note 2)

NOTES:
1. *Uses 48952 switch*
2. *Uses 87-86080 switch*

Switch Identification (Figure 4)



a - 48952 Switch with Red Mylar Sleeve
b - 87-86080 Switch with Black Mylar Sleeve

Figure 4. Water Temperature Switches

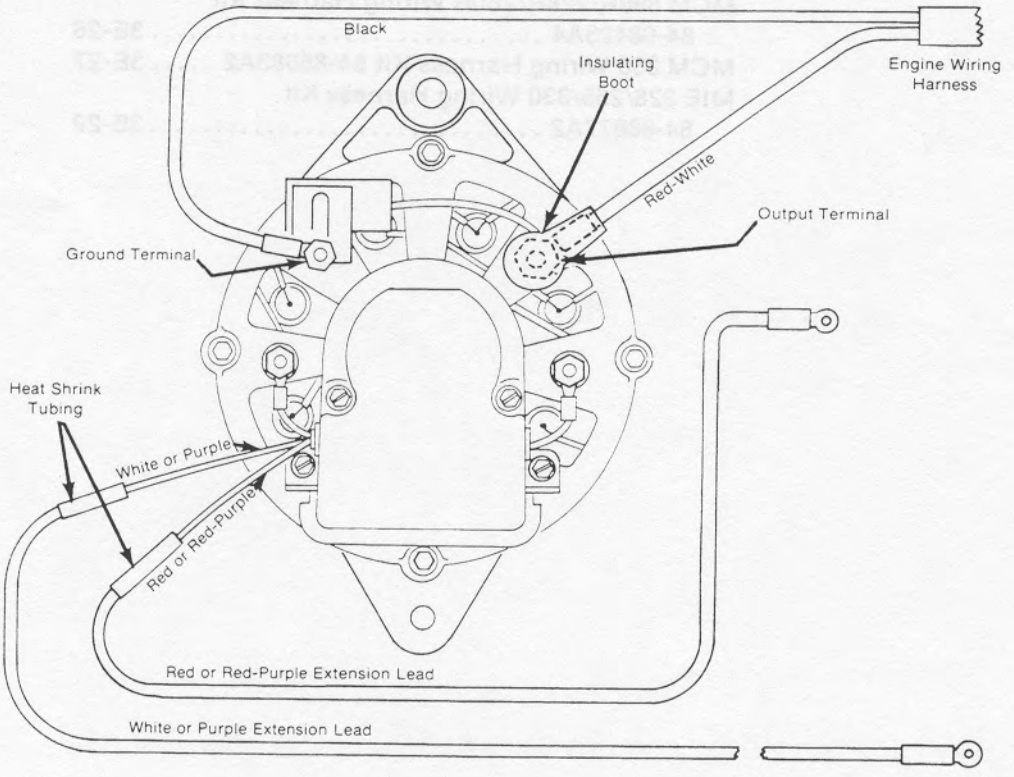
TRANSMISSION FLUID TEMPERATURE SWITCH

Switch is located on transmission. Also, switch is normally open. This switch is used on MCM 330 (B-W) and MIE 230/260/340 engines.

87-88031 SWITCH	
Opens	180° F - 200° F (82° C - 93° C)
Closes	220° F - 240° F (104° C - 116° C)

SECTION 3 - ELECTRICAL SYSTEM

PART E - ELECTRICAL KITS



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MCM 165 Wiring Harness Kit 84-86674A2	3E-19
MCM 470/485 Wiring Harness Kit 84-86675A2	3E-22
MCM 898/228/260 Wiring Harness Kit 84-86676A2	3E-24
MCM 898R/228R/260R Wiring Harness Kit 84-98423A4	3E-26
MCM 330 Wiring Harness Kit 84-86683A2	3E-27
MIE 228/255/330 Wiring Harness Kit 84-86677A2	3E-29

ALTERNATOR 78403A2
(37 AMP)
Installation Instructions

NOTICE: This Alternator Replaces Delco 37 Amp Alternators (56045, 59755, 59756, 68085, 69729, 78477 and 90793) and All Motorola 37 Amp Alternators.

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing alternator.

1. Remove old alternator and install new alternator, using same mounting fasteners.
2. Adjust alternator drive belt tension.

IMPORTANT: To comply with BIA standard wire color coding, some of the alternators and engine wiring harnesses may be equipped with a red-purple lead (in place of a red lead) and a purple lead (in place of a white lead).

3. If alternator is being used to replace Delco Single-Wire Alternators (56045, 59755, 59756, 68085 or 69729), connect wires as follows: (Figure 1)
   a. Fasten extension harness leads to engine at least once every 18" (460mm) with sta-straps, making sure that leads clear all moving parts and DO NOT rub or get pinched.
4. If alternator is being used to replace Delco 3-Wire Alternator (78477 or 90793) or Motorola Alternators, connect wires as follows: (Figure 2)
   a. Discard extension harness that is supplied with alternator.
5. Reconnect battery cables to battery.

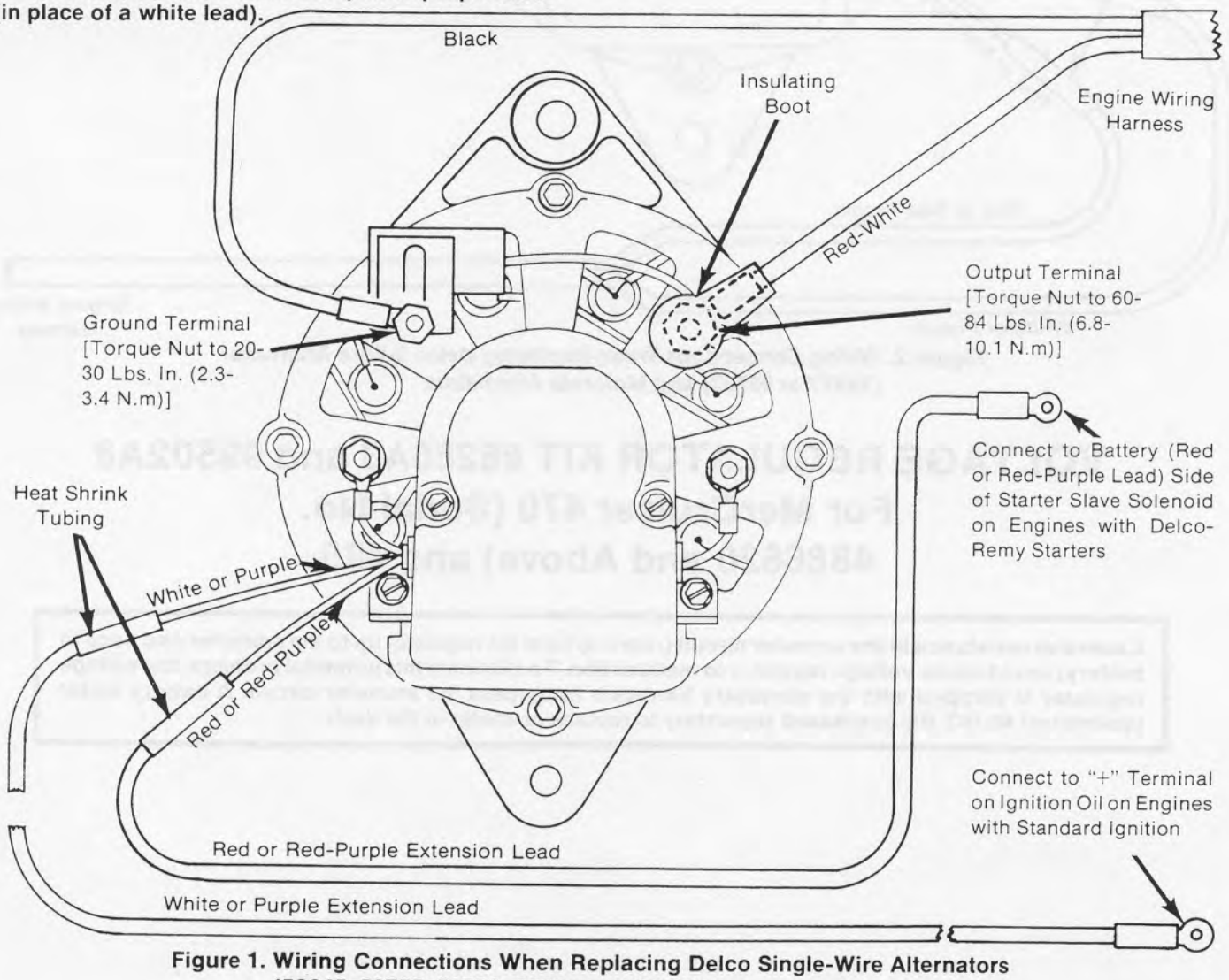


Figure 1. Wiring Connections When Replacing Delco Single-Wire Alternators (56045, 59755, 59756, 68085 and 69729)

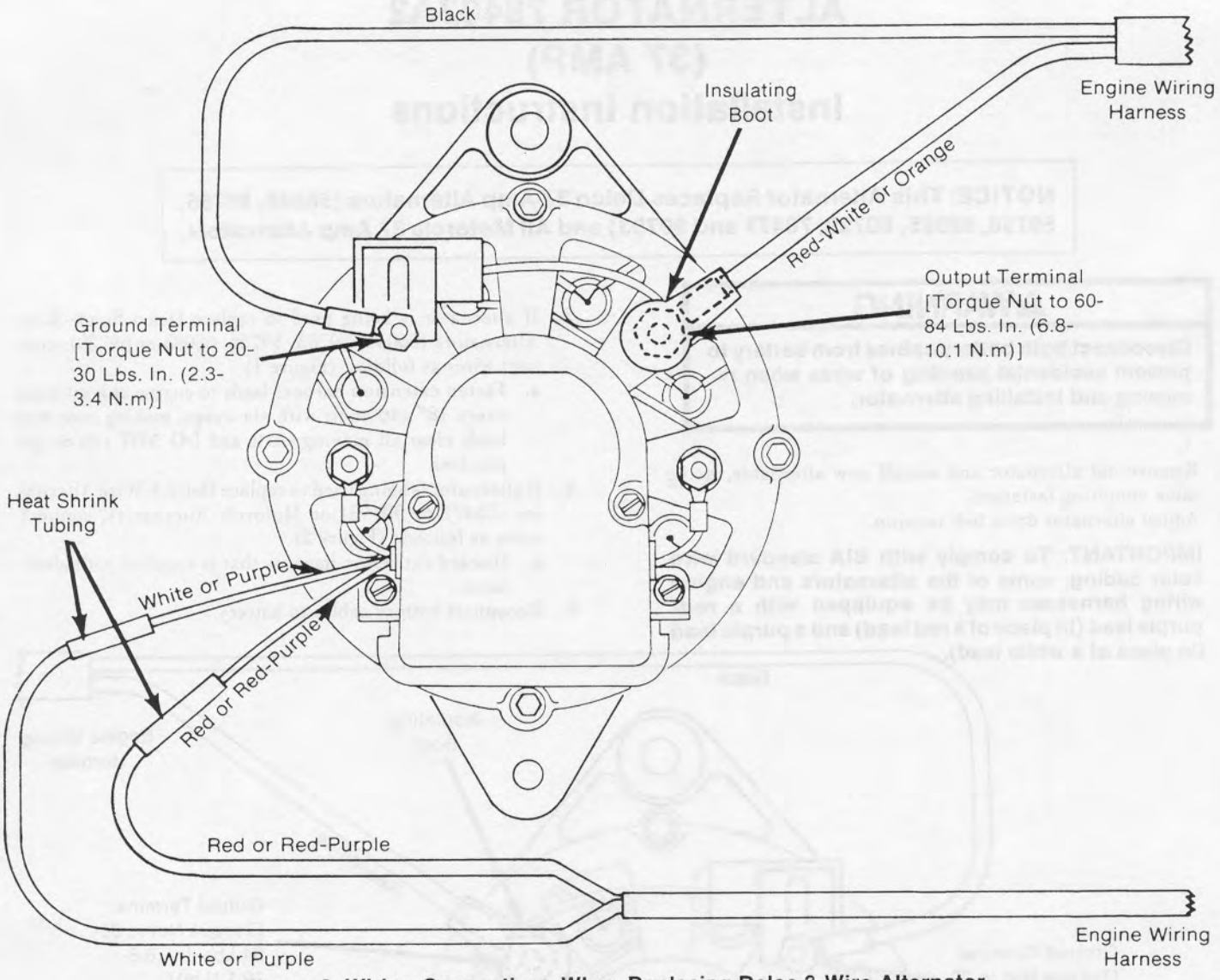


Figure 2. Wiring Connections When Replacing Delco 3-Wire Alternator (78477 or 90793) and Motorola Alternators

VOLTAGE REGULATOR KIT 86255A3 and 99502A8 For MerCruiser 470 (Serial No. 4886620 and Above) and 485

Excessive resistance in the ammeter circuit (running from the regulator up to the ammeter and back to battery) could cause voltage regulator to malfunction. To eliminate this potential problem, the voltage regulator is shipped with the necessary hardware to by-pass the ammeter circuit. A battery meter (voltmeter) MUST BE purchased separately to replace ammeter in the dash.

Regulator Installation

⚠WARNING

Disconnect ALL battery cables from battery BEFORE proceeding with Voltage Regulator Kit installation.

1. Install new voltage regulator, using original fasteners. Be sure to tighten fasteners securely.
2. Install orange jumper wire (supplied in kit) between "Output" terminal and "Sense" terminal, as shown in Figure 1.
3. Coat ALL connections with Liquid Neoprene; then, slide rubber insulating boots (Figure 1) into position over "Sense" and "Output" terminals.
4. Install water hoses (from kit), as shown in Figure 2.

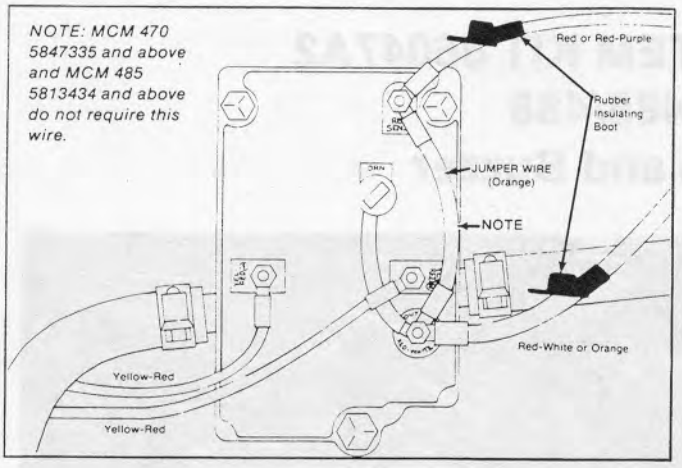


Figure 1. Orange Jumper Wire Installed

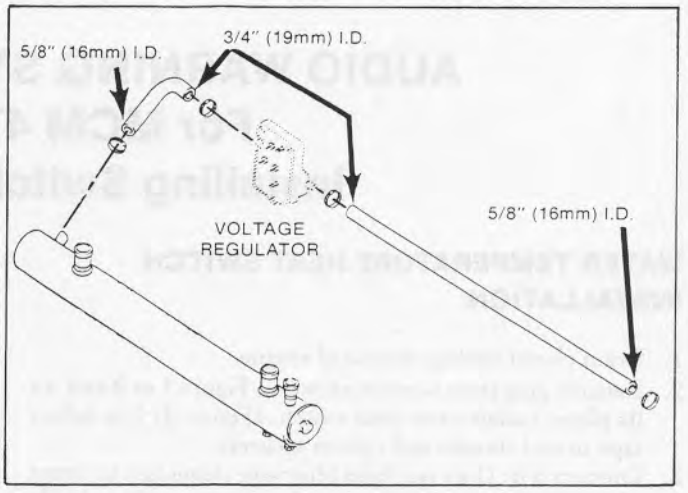


Figure 2. Hose Installation (99502A8 Kit Only)

Battery Meter (Voltmeter) Installation

1. Remove ammeter from dash.
2. Install battery meter (voltmeter) into dash in accordance with instructions provided with gauge.

⚠CAUTION

DO NOT remove hex nuts which are already fastened on battery meter terminals (except as in "Note", following). Hex nuts are provided in kit for connecting wires.

NOTE: If a separate switch (other than ignition switch) is to be used for dash lights, remove hex nut and screw, which secure metal link (Figure 3) to "I" terminal and light bulb socket, and remove link. Reinstall hex nut on "I" terminal and connect dash light wire to light bulb socket terminal with screw.

3. Connect black wire (disconnected from ammeter) to "G" (ground) terminal on battery meter. (Figure 3)
4. Connect white or purple wire (disconnected from ammeter) to "I" (ignition) terminal on battery meter (voltmeter). (Figure 3)

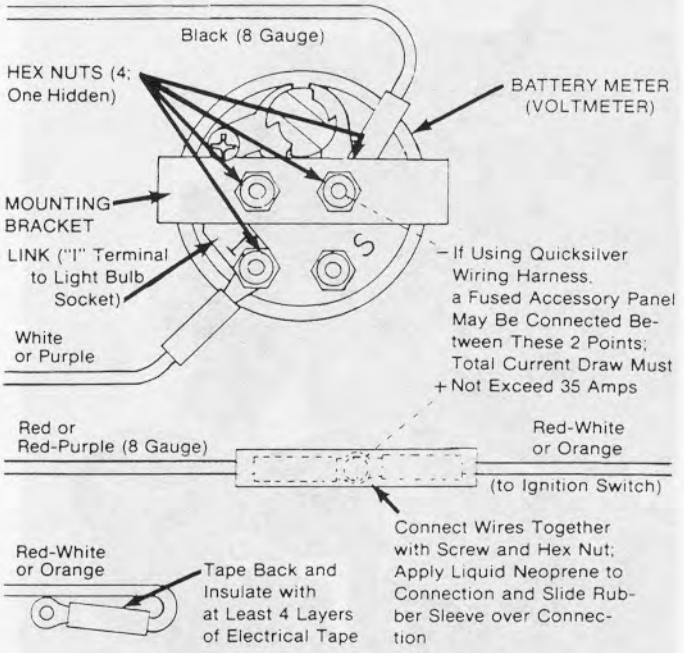


Figure 3. Battery Meter Installation

NOTE: If ammeter did not have a white or purple lead connected to it, use a purple extension wire and connect "I" terminal on battery meter to "I" terminal on water temperature gauge or oil pressure gauge. ["I" terminal is the one with white or purple wire(s) connected to it.]

5. Coat all electrical connections with Liquid Neoprene.
6. Connect red or red-purple wire (disconnected from ammeter) to red-white or orange IGNITION SWITCH wire (disconnected from ammeter) with screw, hex nut and rubber sleeve. (Figure 3) Coat connection with Liquid Neoprene before sliding sleeve over connection.
7. Tape back red-white or orange wiring harness wire (disconnected from ammeter) and insulate ring terminal on end of wire with at least 4 layers of electrical tape. (Figure 3)

⚠CAUTION

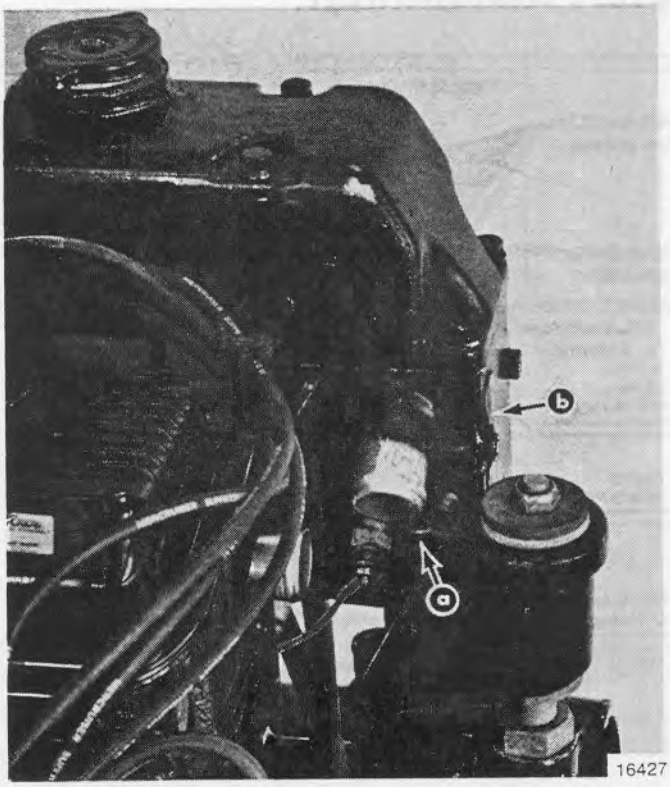
If an accessory fused panel is to be installed, be sure to connect it at screw, nut and sleeve connection and at black wire terminal on battery meter, as shown in Figure 3. DO NOT connect accessory panel at any other location, as wires in wiring harness may be of insufficient size to handle current load.

8. Reconnect battery cables.

AUDIO WARNING SYSTEM KIT 86047A2
For MCM 470/485/488
Installing Switches and Buzzer

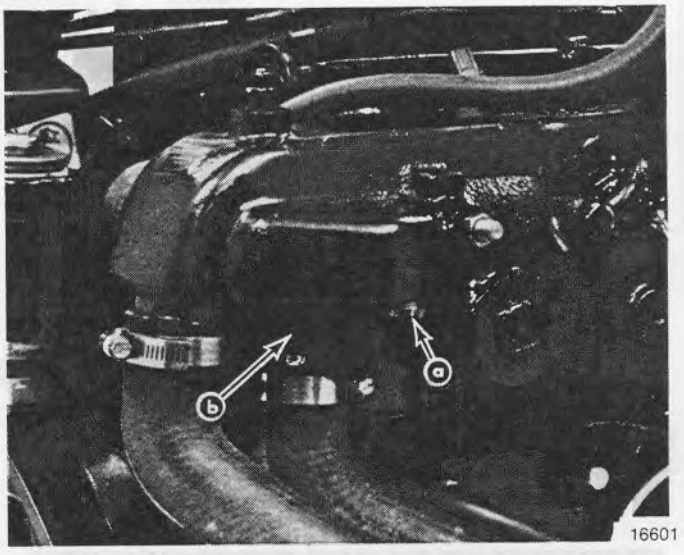
WATER TEMPERATURE HEAT SWITCH INSTALLATION

1. Drain closed cooling section of engine.
2. Remove plug from location shown in Figure 1 or 2 and, in its place, install water heat switch. (Figure 3) Use teflon tape to seal threads and tighten securely.
3. Connect 3 ft. (1m) tan/light blue wire (from kit) to water temperature heat switch; route wire to the starboard side of engine and back to oil plug location shown in Figure 4.
4. Secure wire to engine wiring harness, being sure it will not come in contact with any moving parts.



a - Water Plug b - Thermostat Housing

Figure 1. Water Plug Location (MCM 470 Serial No. 6208036 and Below)



a - Water Plug b - Thermostat Housing

Figure 2. Water Plug Location [MCM 470 (Serial No. 6218037 and Above) and 485/488]

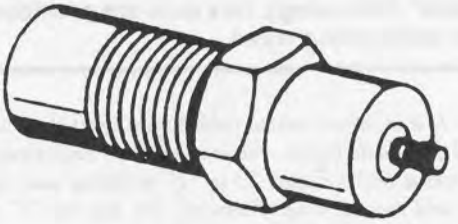
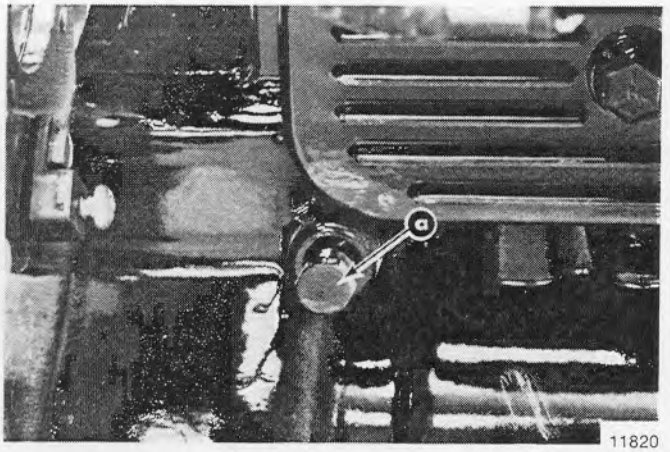


Figure 3. Water Heat Switch



a - Oil Plug

Figure 4. Oil Plug Location

OIL PRESSURE SWITCH INSTALLATION

1. Remove oil plug from location shown in Figure 4.
2. Install oil pressure switch (Figure 5) in location where plug was removed. Use teflon tape to seal threads and tighten securely.
3. Connect tan/light blue lead (from water temperature heat switch) to oil pressure switch.

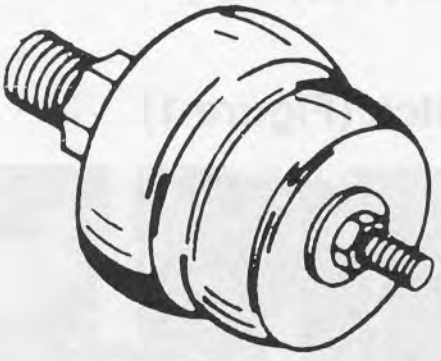


Figure 5. Oil Pressure Swtich

WARNING BUZZER INSTALLATION (Figure 6)

1. Disconnect battery leads, if not already disconnected.
2. Mount buzzer (Figure 6) under dashboard with 2 screws (from kit) in location that is not in obvious sight but is easily accessible for installation and maintenance. Location should not restrict buzzer sound and also should be within limits of 18" (457mm) purple lead. (Lead will be connected to instrument terminal in dashboard.)

⚠WARNING

Buzzer is not external ignition-proof, therefore, DO NOT mount buzzer in engine or fuel tank compartments.

3. Attach purple lead to "+ 12V" switched terminal of any adjacent gauge [purple to purple (BIA) or purple to white (earlier MerCruiser)]. The attaching terminal should be "off" when ignition switch is in Off" position.

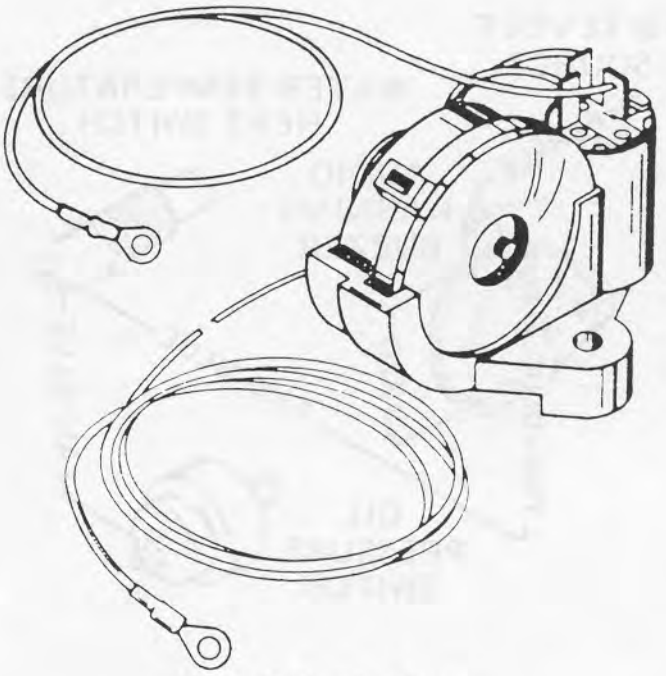


Figure 6. Warning Buzzer

4. Route tan/light blue wire from buzzer back to engine compartment, supporting wire every 18". Be sure that wire does not chafe or get pinched and does not come in contact with bilge water or moving parts.
5. Connect tan/light blue lead from buzzer to engine water heat switch or oil pressure switch, whichever is more accessible.
6. Place decal (Figure 7) on bottom of glass face of water temperature gauge and oil pressure gauge.

ALARM INDICATES LOW OIL OR OVERHEATING

Figure 7. Decal (To Be Placed on Face of Gauge)

ENGINE SENSOR HORN WILL SOUND WHEN OIL PRESSURE IS TOO LOW OR TEMP. IS TOO HOT.

TO TEST HORN

1. TURN KEY TO ON POSITION (ENGINE OFF)
2. WAIT 7 TO 14 SEC. FOR HORN TO SOUND

Figure 8. Decal (To Be Placed on Dashboard)

7. Place decal (Figure 8) in convenient location on dashboard.
8. Fill engine Closed Cooling System with water/anti-freeze solution.
9. Reconnect battery leads.
10. Test switch (horn), as explained on decal. (Figure 8)
11. Seal all electrical connections with Quicksilver Liquid Neoprene.

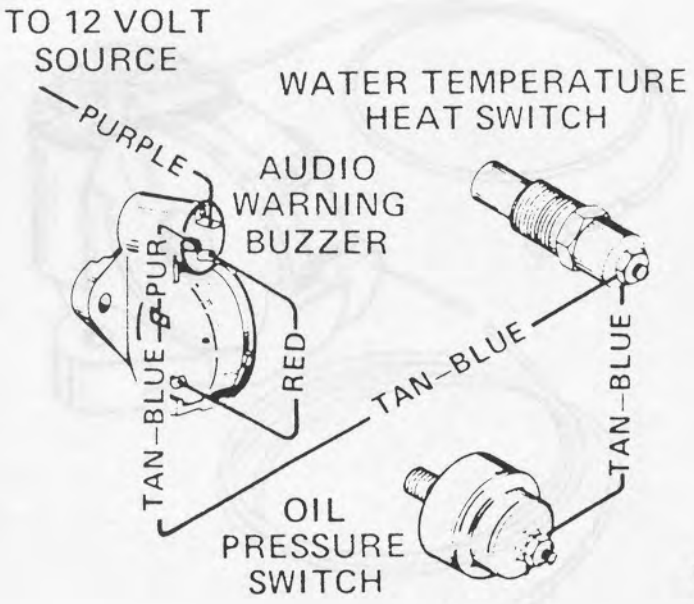


Figure 9. Audio Warning System Wiring Diagram

AUDIO WARNING SYSTEM KIT 86047A3 For MCM 120, 140, 165, 898, 228, 260, 330TR/TRS

Installing Water Heat Switch (Figure 1)

INSTALLING WATER HEAT SWITCH on IN-LINE ENGINES with STANDARD and CLOSED COOLING

NOTE: On standard cooled engines, temperature switch is designed for thermostat housing 47587A2. If thermostat housing 63908A2 is on engine, 1/8-27NPTF tapped hole must be drilled and tapped to 3/8-18NPTF. Remove housing to make modification, then blow out with compressed air to remove metal chips and reinstall housing with a new gasket.

NOTE: On closed cooled engines, reducing bushing 22-52382 (not in kit) must be installed into thermostat housing before heat switch.

1. Drain cooling system.

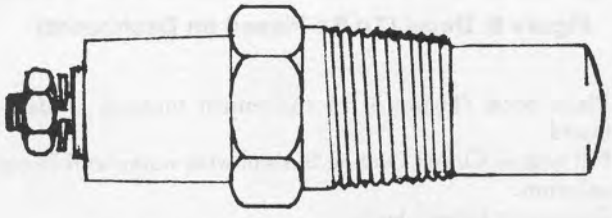
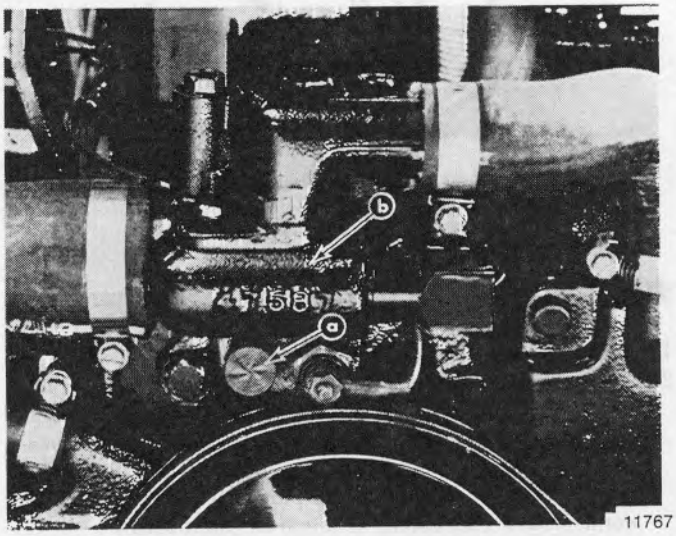


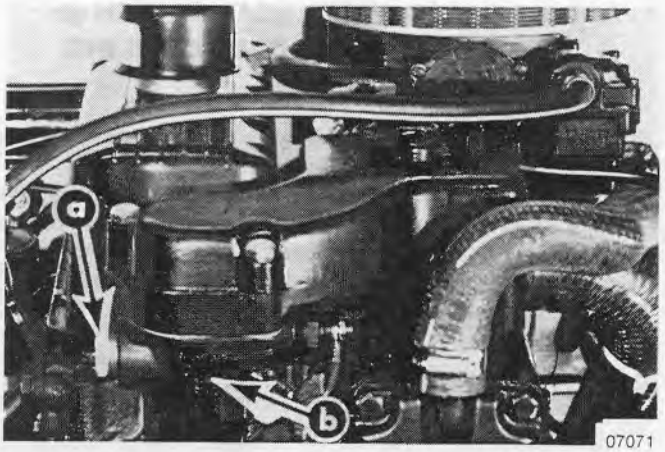
Figure 1. Water Heat Switch



a - Plug b - Thermostat Housing

Figure 2. In-Line Standard Cooling

2. Remove plug from thermostat housing at location shown in Figure 2 or 3.
3. Install water heat switch from kit into thermostat housing. Use teflon tape to seal threads and tighten securely.



a - Plug b - Thermostat Housing

Figure 3. In-Line Closed Cooling

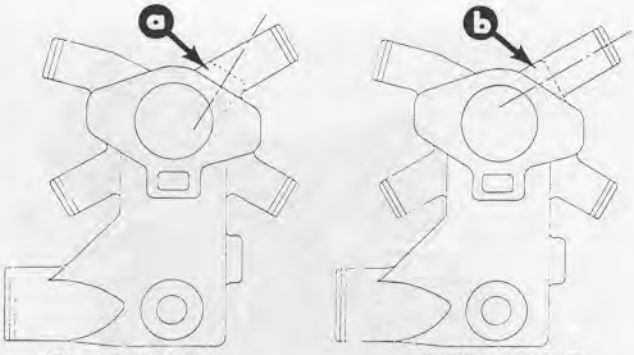
4. Attach 3 ft. (914mm) tan/light blue wire (from kit) to heat switch with nut and lockwasher.

5. Route tan/light blue wire toward starboard side, then back to oil sender (to be removed later). Secure wire to wire harness (located on starboard side of engine), being sure that wire will not come in contact with hot spots or moving parts.

INSTALLING WATER HEAT SWITCH on V-8 ENGINES with STANDARD COOLING

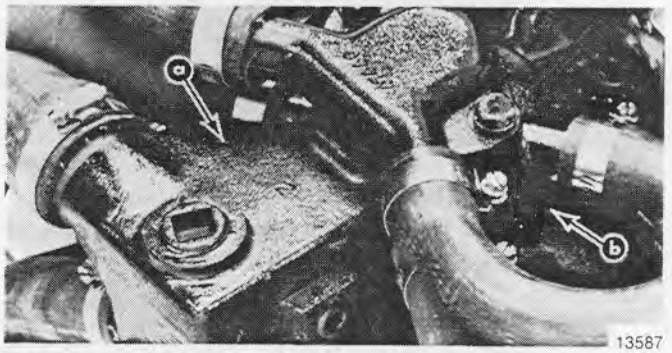
NOTE: MCM 898, 228, 260 and 330 - check thermostat housing to determine if housing is the new style or old style. (Figure 4) New style thermostat housing has the hole (in which heat switch will be installed) threaded on the same angle as the hose connection above it. If hole is not threaded on the same angle, thermostat housing is the old style and must be replaced with new style thermostat housing (78984A1) on 228 and 260 models or (79468A1) on 330 models. If 898 model is equipped with old style thermostat housing, install water heat switch in the intake manifold, as explained in Step 4.

1. Drain cooling system.
2. Disconnect hoses from thermostat housing.
3. Remove thermostat housing (Figure 5) from engine and scrape gasket material from all mating surfaces.
4. Install water heat switch as follows:
   a. On 898 models with old style thermostat housing
      (1) Remove pipe plug from intake manifold and install water heat switch in its place, using teflon tape to seal threads. (Figure 6) Tighten water heat switch securely.
      (2) Attach 3 ft. (914mm) tan/light blue wire (from kit) to switch with nut and lockwasher. Route wire over intake manifold to and along port rocker arm cover and down toward oil filter (oil pressure switch to be installed in this location later). Secure wire to water hose, being sure that wire does not come in contact with hot spot on intake manifold. (Figure 6)
      (3) Reinstall thermostat housing, using Perfect Seal and new gasket from kit. Torque screws to 30 lbs. ft. (41 N.m).
      (4) Reconnect water hoses (removed in Step 2) to their respective locations.
   b. On all other models (except 898 with old style thermostat housing)



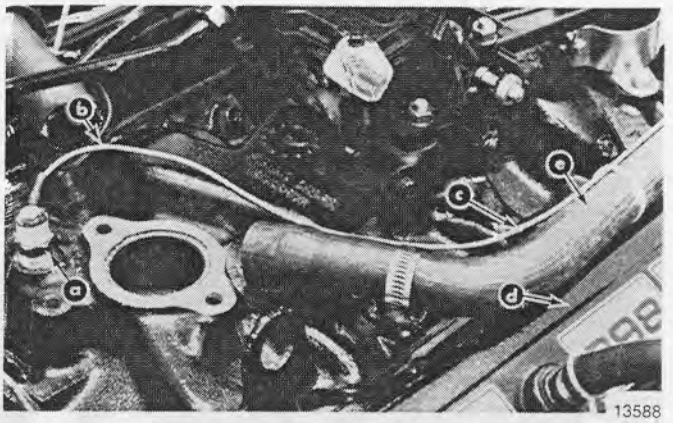
a - Threads Cut at an Angle to Hose Connection
b - Threads Cut at Same Angle as Hose Connection

Figure 4. New and Old Style Thermostat Housings



a - Thermostat Housing
b - Pipe Plug (on Aft Side of Thermostat Housing; Hidden)

Figure 5. V-8 Standard Cooling Thermostat Housing

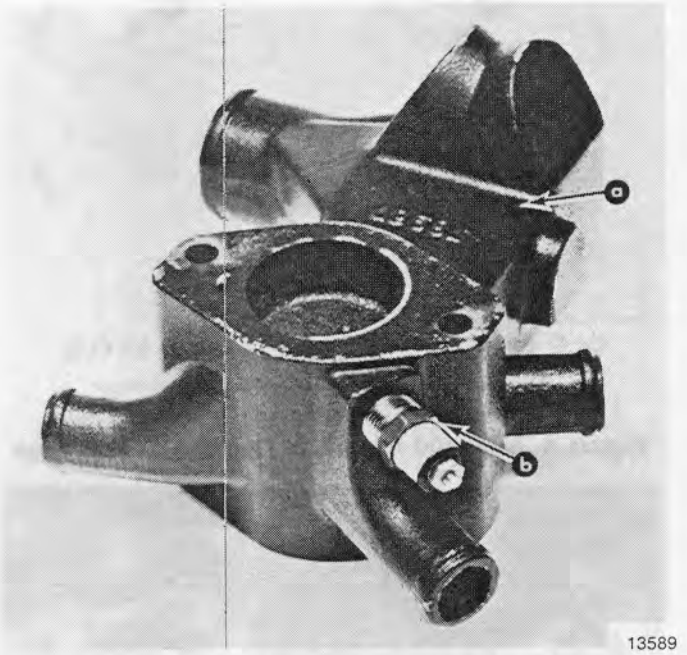


a - Water Heat Switch
b - Tan/Light Blue Wire (Route and Fasten as Shown)
c - Intake Manifold Hot Spot
d - Port Rocker Arm Cover
e - Secure Wire to This Water Hose

Figure 6. Water Heat Switch Installed

(1) Install water heat switch into aft side of thermostat housing, using teflon tape to seal threads. (Figure 7) Tighten water heat switch securely.

IMPORTANT: MCM 898R, 228R and 260R Models - check water heat switch to ensure that switch does not interfere with thermostat. If interference does exist, thermostat and related parts must be rearranged as shown in Figure 10.



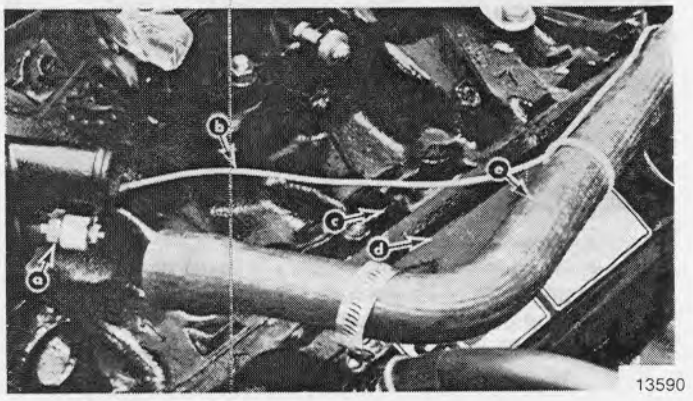
a - Thermostat Housing b - Water Heat Switch

Figure 7. Water Heat Switch Installed on Aft Side of New Style Thermostat Housing

(2) Install thermostat housing with new gasket (with continuity rivets) from kit. Torque screws to 30 lbs. ft. (41 Nm).

(3) Attach 3 ft. (914mm) tan/light blue wire (from kit) to heat switch with nut and lockwasher. Route wire along port rocker arm cover and down toward oil filter (oil pressure switch to be installed in this location later). Secure wire to water hose, being sure that wire does not come in contact with hot spot on intake manifold. (Figure 8)

(4) Reconnect water hoses (removed in Step 2) to their respective locations.

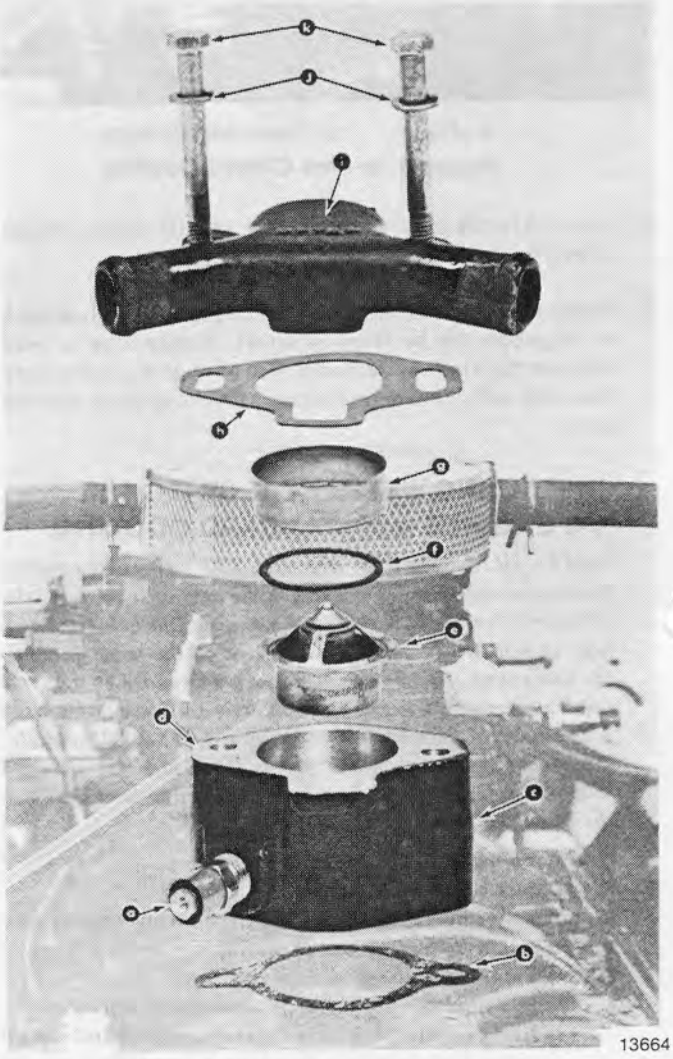


a - Water Heat Switch
b - Tan/Light Blue Wire (Route and Fasten as Shown)
c - Intake Manifold Hot Spot
d - Port Rocker Arm Cover
e - Secure Wire to This Water Hose

Figure 8. Water Heat Switch Wire Properly Routed

INSTALLING WATER HEAT SWITCH on V-8 ENGINES with CLOSED COOLING

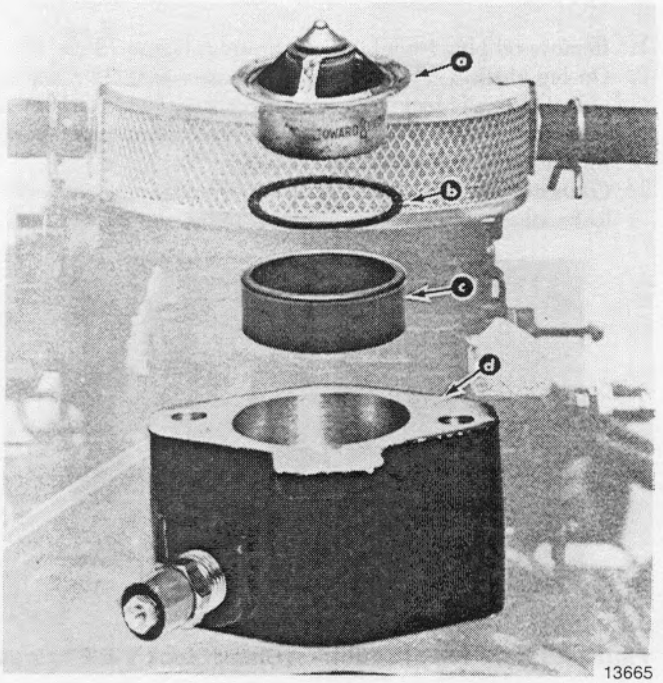
1. Drain cooling system.
2. Remove thermostat housing and cover, then scrape gasket material from all mating surfaces.
3. Remove pipe plug from front of thermostat housing and install water heat switch in its place, using teflon tape to seal threads. (Figure 9) Tighten heat switch securely.
4. Install thermostat and related parts in sequence shown in Figure 9.



a - Water Heat Switch
b - Ground Gasket (Housing to Intake Manifold)
c - Pipe Plug (Hidden)
d - Thermostat Housing
e - Thermostat
f - Cork Gasket (Thermostat to Sleeve)
g - Sleeve (Turned in Lip Down)
h - Gasket (Thermostat Housing to Cover)
i - Thermostat Housing Cover
j - Lockwashers
k - Bolts

Figure 9. V-8 Closed Cooling Thermostat Housing Assembly

IMPORTANT: Check water heat switch to ensure that heat switch DOES NOT interfere with thermostat. If interference does exist, thermostat and related parts MUST BE rearranged as shown in Figure 10.



a - Thermostat
b - Cork Gasket
c - Sleeve (Turned in Lip Up)
d - Thermostat Housing

Figure 10. Thermostat and Related Parts Rearranged if Heat Switch Interferes with Thermostat

5. Install thermostat housing and cover, using gasket (with continuity rivets) from kit and new thermostat cover gasket. (Figure 9) Use Perfect Seal on gasket cover before installing. Torque bolts to 30 lbs. ft. (41 N.m).
6. Attach 3 ft. (914mm) tan/light blue wire (from kit) to switch with nut and lockwasher.
7. Route wire to and along port rocker arm cover and down toward oil filter (oil pressure switch to be installed in this location later). Secure wire to water hose, being sure that wire does not come in contact with hot spot on intake manifold, as shown in Figure 6.

Installing Oil Pressure Switch (Figure 11)

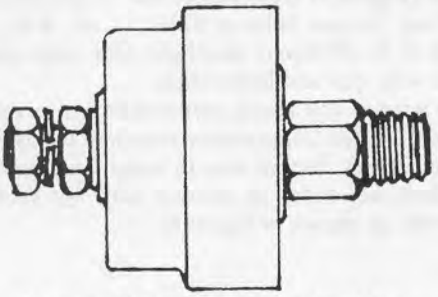
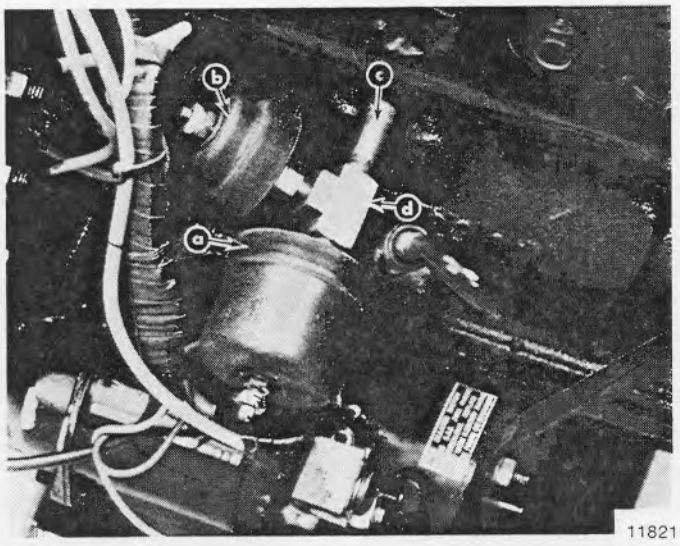


Figure 11. Oil Pressure Switch

INSTALLING OIL PRESSURE SWITCH on IN-LINE ENGINES

1. Disconnect both battery leads at battery.
2. Disconnect wire from oil sender and remove sender (also nipple and elbow, if so equipped).
3. Install nipple, then tee fitting (from kit), using teflon tape to seal threads. (Figure 12)
4. Install oil pressure switch and oil sender in position on tee as shown in Figure 12. Tighten fittings securely.
5. Reconnect wire to oil sender (previously removed) and connect wire from heat switch to oil pressure switch. Torque nut to 15 lbs. in. (1.7 N.m).

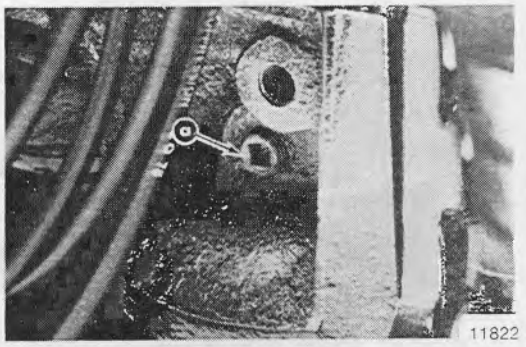


a - Oil Sender
b - Oil Pressure Switch
c - Nipple
d - Tee Fitting

Figure 12. Oil Pressure Switch Installed on In-Line Engines

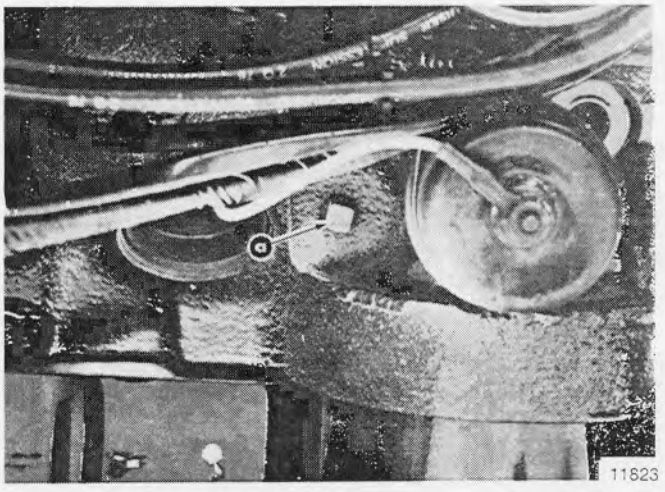
INSTALLING OIL PRESSURE SWITCH on V-8 ENGINES

1. Remove oil plug from location shown in Figure 13 or 14.
2. On big block V-8's, install oil pressure switch in place of plug. On small block V-8's, install reducer (from kit) and oil pressure switch in place of plug. Use teflon tape to seal threads and tighten fittings securely.
3. Connect wire from heat switch to oil pressure switch with lockwasher and nut. Torque nut to 15 lbs. in. (1.7 N.m).



a - Oil Plug

Figure 13. Oil Plug Location on Small Block V-8 Engines



a - Oil Plug

Figure 14. Oil Plug Location on Big Block V-8 Engines

Installing Warning Buzzer (Figure 15)

1. Disconnect battery leads, if not already disconnected.
2. Mount buzzer (Figure 15) under dashboard with 2 screws (from kit) in location that is not in obvious sight but is easily accessible for installation and maintenance. Location should not restrict buzzer sound and also should be within limits of 18″ (460mm) purple lead. (Lead will be connected to instrument terminal in dashboard.)

⚠WARNING

Buzzer is not external ignition-proof, therefore, DO NOT mount buzzer in engine or fuel tank compartments.

3. Attach purple lead to "+ 12V" switched terminal of any adjacent gauge [purple to purple (BIA) or purple to white (earlier MerCruiser)]. The attaching terminal should be "off" when ignition switch is in "Off" position.
4. Route tan/light blue wire from buzzer back to engine compartment, supporting wire every 18″. Be sure that wire does not chafe or get pinched and does not come in contact with bilge water or moving parts.
5. Connect tan/light blue lead from buzzer to engine water heat switch or oil pressure switch, whichever is more accessible with lockwasher and nut. Torque nut to 15 lbs. in. (1.7 N.m). (DO NOT over-tighten.)

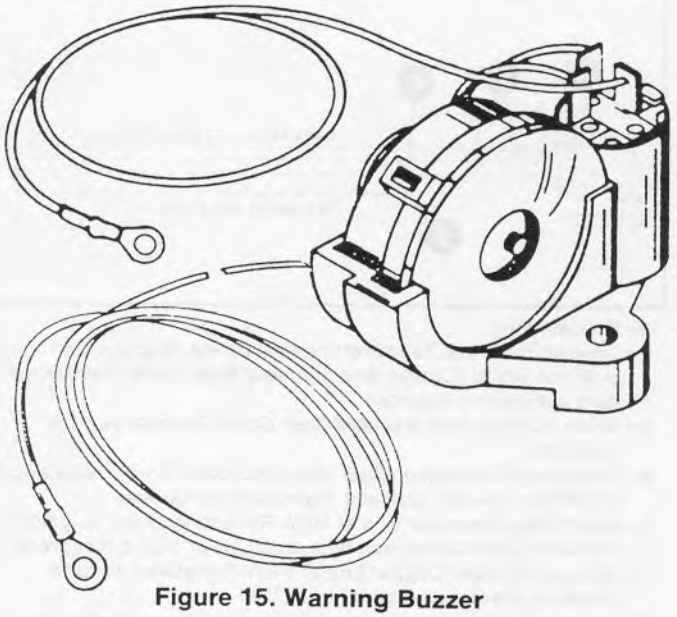


Figure 15. Warning Buzzer

6. Place decal (Figure 16) on bottom of glass face of water temperature gauge and of oil pressure gauge, if equipped.
7. Place decal (Figure 17) in convenient location on dashboard.

ALARM INDICATES LOW OIL OR OVERHEATING

Figure 16. Decal (To Be Placed on Face of Gauge)

ENGINE SENSOR HORN WILL SOUND WHEN OIL PRESSURE IS TOO LOW OR TEMP. IS TOO HOT.

TO TEST HORN

1. TURN KEY TO ON POSITION (ENGINE OFF)
2. WAIT 7 TO 14 SEC. FOR HORN TO SOUND

Figure 17. Decal (To Be Placed on Dashboard)

8. Reconnect battery leads.
9. Fill Closed Cooling System (on engines so equipped) with water/anti-freeze solution.
10. Test switch (horn) as explained on decal. (Figure 17)
11. Seal all electrical connections with Liquid Neoprene.

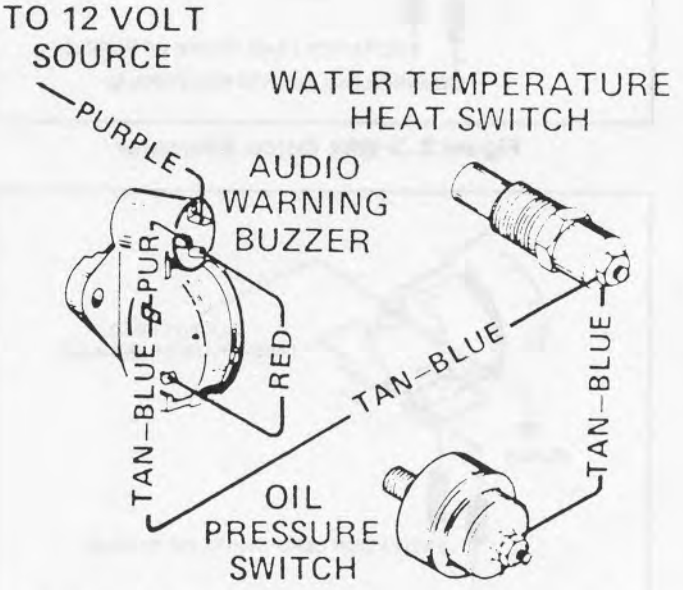


Figure 18. Audio Warning System Wiring Diagram

Resistance Wire Replacement Kit 84-94227A2
Installation Instructions

1. Determine if engine is equipped with a 1 or 3 wire alternator system (Figure 1, 2 or 3). Refer to Figure 7 if resistance wire is to be installed on a 470, 485 or 488 Model.

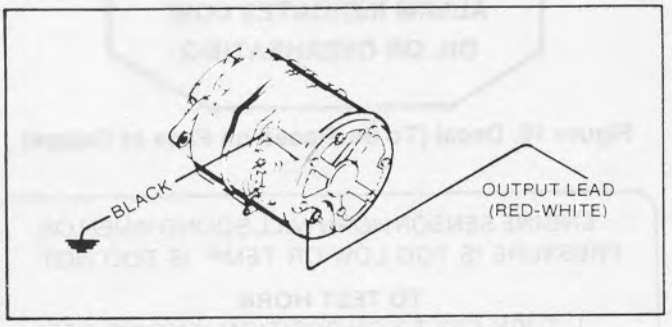


Figure 1. 1-Wire Delco Alternator

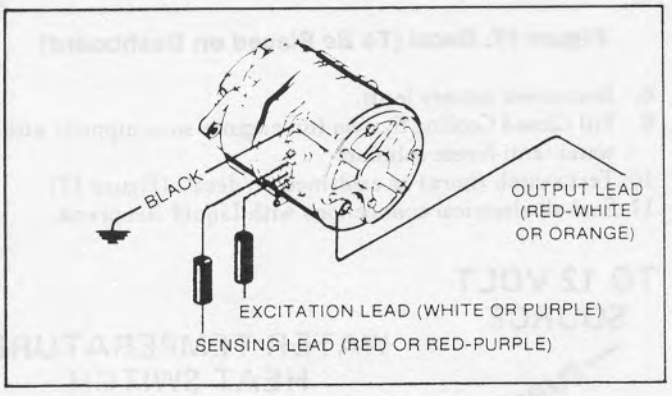


Figure 2. 3-Wire Delco Alternator

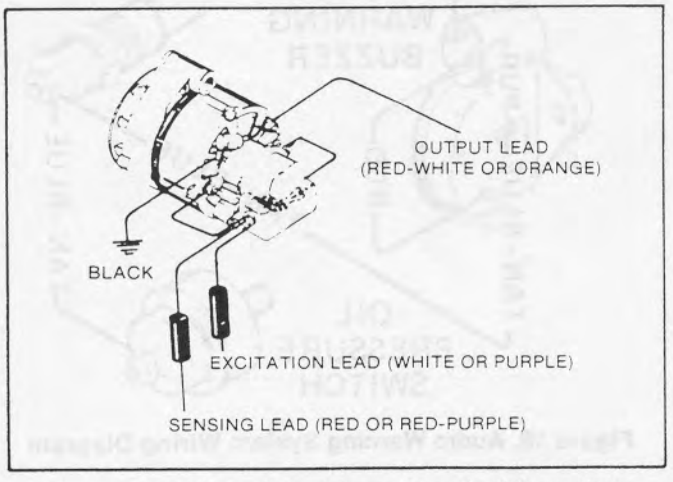
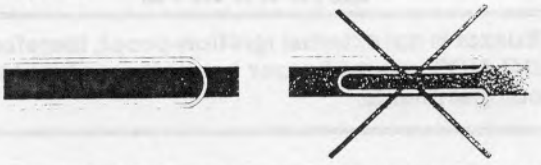


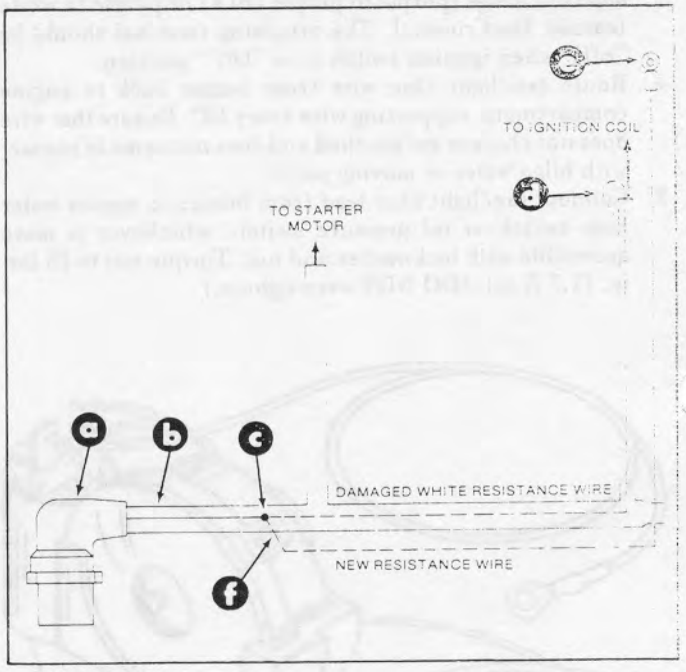
Figure 3. 3-Wire Motorola or Mando Alternators

2. Install new resistance. (Figure 4, 5, 6 or 7)

⚠WARNING

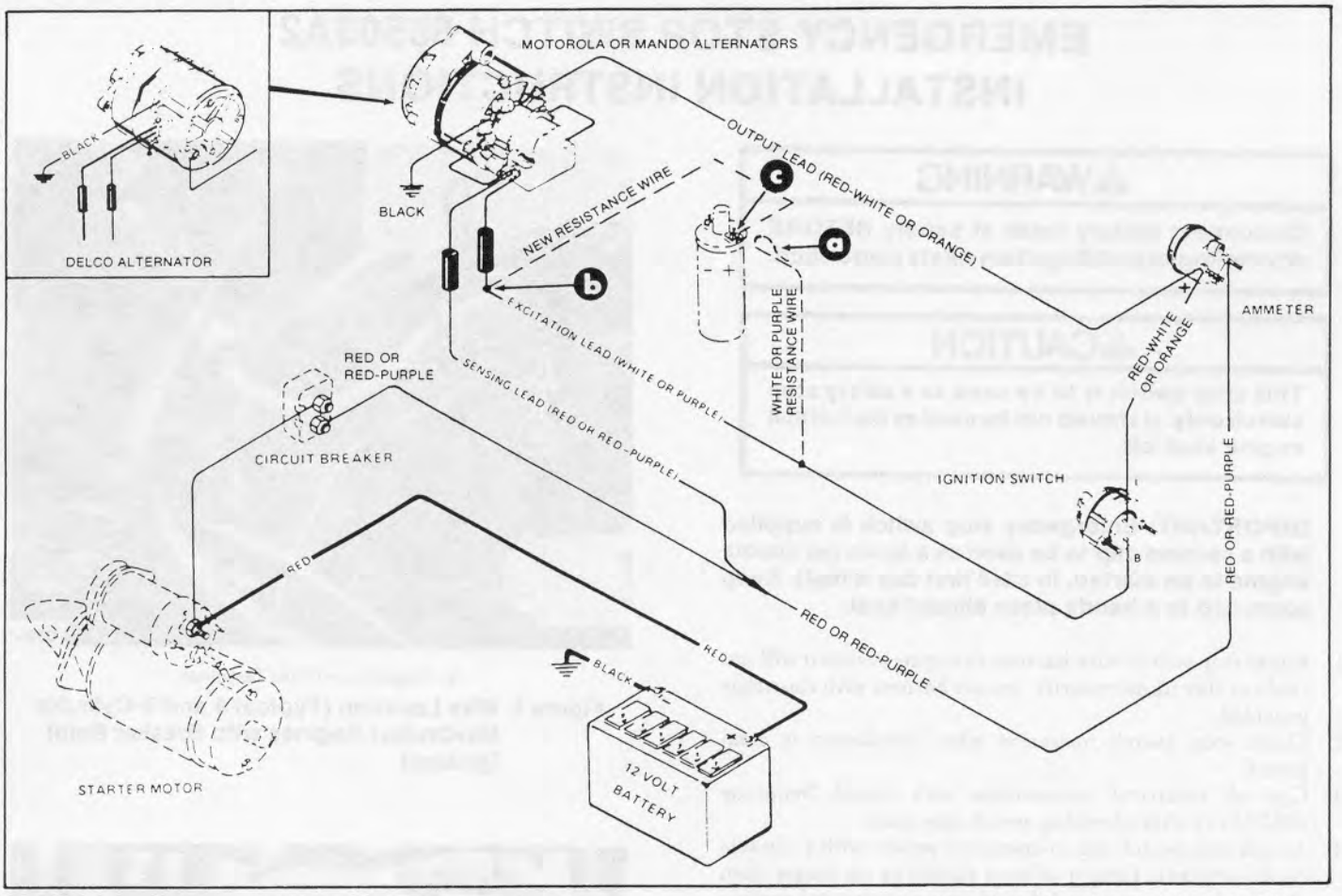
DO NOT tape more than two (2) layers of resistance wire in any one section of engine harness.





a - Harness Plug
b - Unwrap Electrical Tape Starting At Harness Plug and Continue Until the White (Copper and Stainless Steel Core) Resistance Wire Junction Is Exposed
c - White (Copper and Stainless Steel Core) Resistance Wire Junction
d - Disconnect Damaged White (Stainless Steel Core) Resistance Wire From Ignition Coil and Tape Back to Harness
e - Attach Ring Terminal End of NEW Resistance Wire to Ignition Coil and Coat Connection With Quicksilver Liquid Neoprene
f - Wrap and Solder Copper End of NEW Resistance Wire to Junction. Insulate Junction

Figure 4. 1-Wire Delco Alternator System WITHOUT Electric Choke

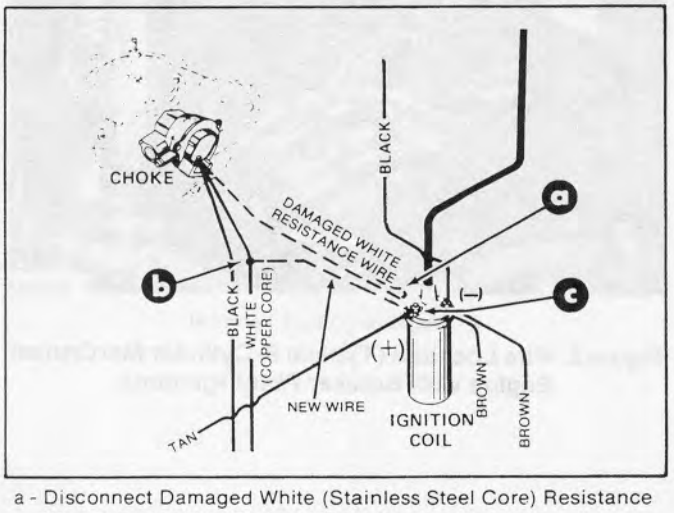


a - Disconnect Damaged White or Purple (Stainless Steel Core) Resistance Wire From Ignition Coil and Tape Back to Harness

b - Strip Outer Insulating Jacket of White or Purple (Copper Core) Wire. Wrap and Solder Copper End of NEW Resistance Wire to White or Purple Wire Insulate Junction.

c - Attach Ring Terminal End of NEW Resistance Wire to Ignition Coil and Coat Connection With Quicksilver Liquid Neoprene

Figure 5. 3-Wire Alternator System With or Without Electric Choke (Typical)

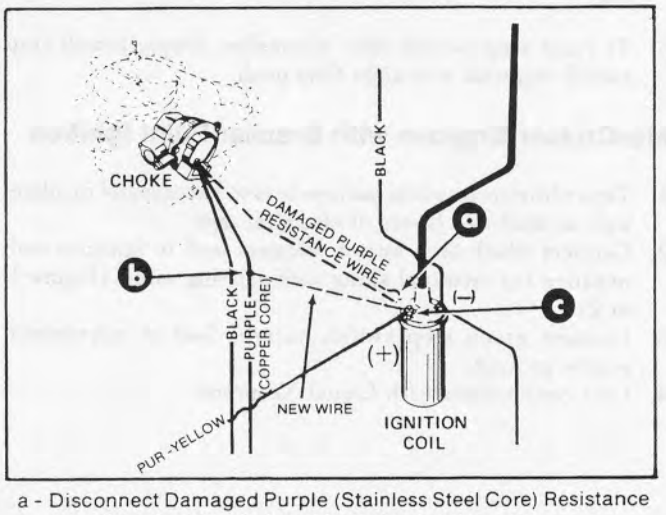


a - Disconnect Damaged White (Stainless Steel Core) Resistance Wire From Ignition Coil and Tape Back to Harness

b - Strip Outer Insulating Jacket of White (Copper Wire) Wire. Wrap and Solder Copper End of NEW Resistance Wire to White Wire. Insulate Junction.

c - Attach Ring Terminal End of NEW Resistance Wire to Ignition Coil and Coat Connection With Quicksilver Liquid Neoprene

Figure 6. 1-Wire Delco Alternator System WITH Electric Choke



a - Disconnect Damaged Purple (Stainless Steel Core) Resistance Wire From Ignition Coil and Tape Back to Harness

b - Strip Outer Insulating Jacket of Purple (Copper Core) Wire. Wrap and Solder Copper End of NEW Resistance Wire to Purple Wire. Insulate Junction.

c - Attach Ring Terminal End of NEW Resistance Wire to Ignition Coil and Coat Connection With Quicksilver Liquid Neoprene

Figure 7. MerCruiser 470/485/488 Resistance Wire Replacement

EMERGENCY STOP SWITCH 65503A2 INSTALLATION INSTRUCTIONS

⚠WARNING

Disconnect battery leads at battery BEFORE attempting to install ignition safety stop switch.

⚠CAUTION

This stop switch is to be used as a safety stop switch only. It should not be used as the normal engine shut-off.

IMPORTANT: Emergency stop switch is supplied with a second cap to be used as a spare (to enable engine to be started, in case first cap is lost). Keep spare cap in a handy place aboard boat.

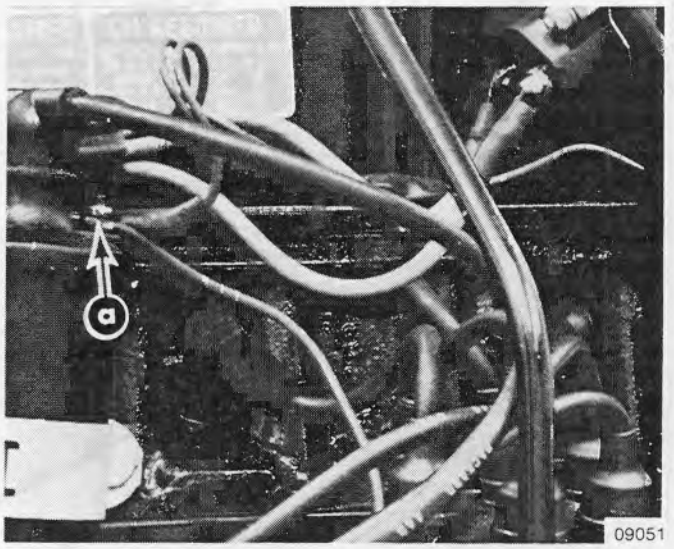
1. Route stop switch wire harness to engine so that it will not chafe or flex unnecessarily. Secure harness with sta-straps provided.
2. Check stop switch operation after installation is completed.
3. Coat all electrical connections with Liquid Neoprene (92-25711) after checking switch operation.
4. Attach stop switch cap to operator's person with a suitable cord (lanyard). Length of cord should be no longer than absolutely necessary and should have a minimum breaking strength of 100 lbs. (45kg).

IMPORTANT: To prevent the possibility of damage to ignition components, turn ignition switch to "Off" position as soon as possible after safety stop switch has been activated.

5. To reset stop switch after activation, simply install stop switch cap with a straight firm push.

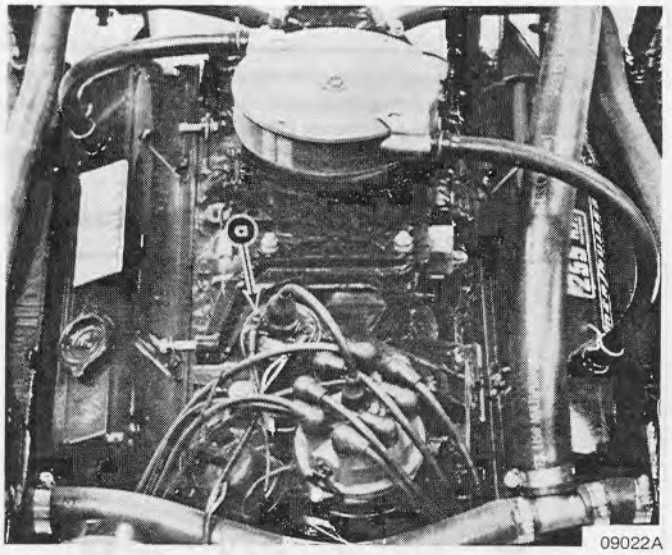
MerCruiser Engines with Breaker Point Ignition

1. Tape white stop switch harness lead to harness and insulate with at least two layers of electrical tape.
2. Connect black stop switch harness lead to ignition coil negative (-) terminal along with existing wires. (Figure 1 or 2)
3. Connect green stop switch harness lead to convenient engine ground.
4. Coat connections with Liquid Neoprene.



a - Negative (-) Coil Terminal

Figure 1. Wire Location (Typical 4 and 6-Cylinder MerCruiser Engines with Breaker Point Ignition)



a - Negative (-) Coil Terminal

Figure 2. Wire Location (Typical 8-Cylinder MerCruiser Engine with Breaker Point Ignition)

MerCruiser Engines with Thunderbolt IV HEI Ignition (Figure 3)

1. Tape white stop switch harness lead to harness and insulate with at least two layers of electrical tape.
2. Connect green stop switch harness lead to distributor terminal which has white-green lead already connected on it.
3. Connect black stop switch harness lead to convenient engine ground.
4. Coat connections with Liquid Neoprene.

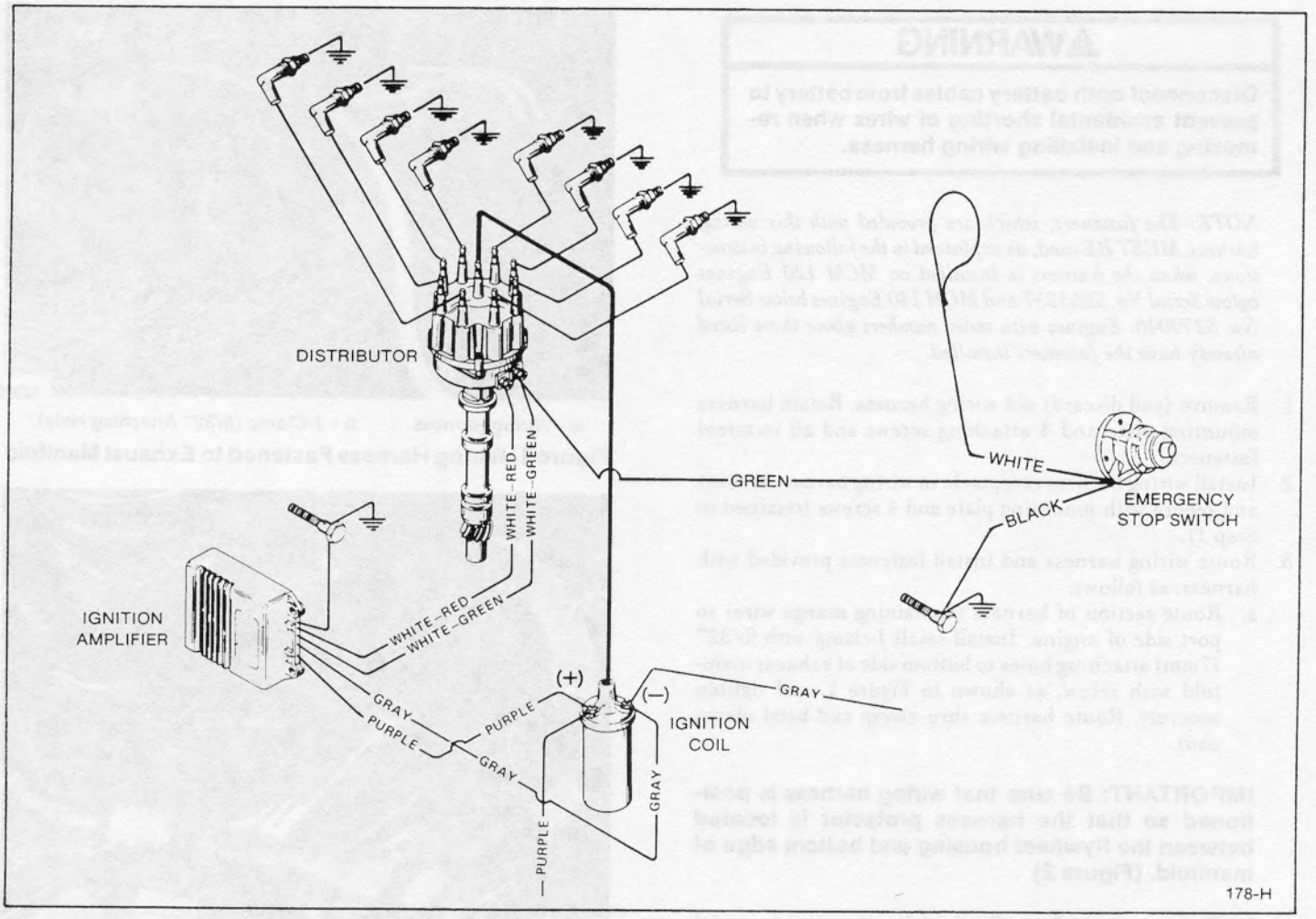


Figure 3. Wire Location [MerCruiser Engines with Thunderbolt IV (HEI) Ignition]

WIRING HARNESS KIT 84-86673A2
For MCM 120/140 Stern Drive Engines
INSTALLATION INSTRUCTIONS

⚠WARNING

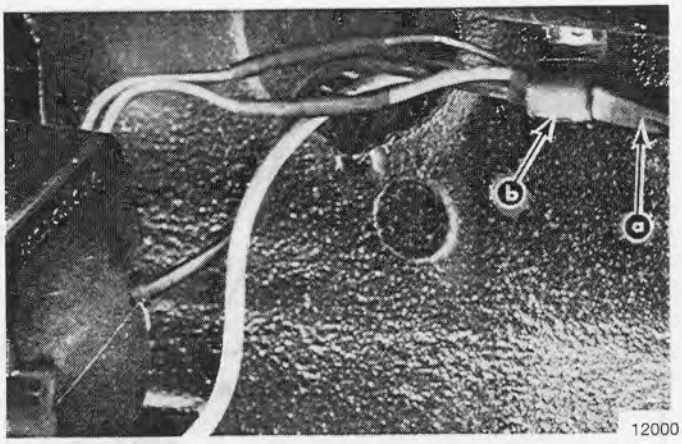
Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

NOTE: The fasteners, which are provided with this wiring harness, MUST BE used, as explained in the following instructions, when the harness is installed on MCM 120 Engines below Serial No. 5263237 and MCM 140 Engines below Serial No. 5279046. Engines with serial numbers above those listed already have the fasteners installed.

1. Remove (and discard) old wiring harness. Retain harness mounting plate and 4 attaching screws and all terminal fasteners.
2. Install wiring harness receptacle in wiring harness bracket and secure with mounting plate and 4 screws (retained in Step 1).
3. Route wiring harness and install fasteners provided with harness, as follows:
   a. Route section of harness (containing orange wire) to port side of engine. Install small J-clamp with 9/32" (7mm) attaching holes to bottom side of exhaust manifold with screw, as shown in Figure 1, and tighten securely. Route harness thru clamp and bend clamp shut.

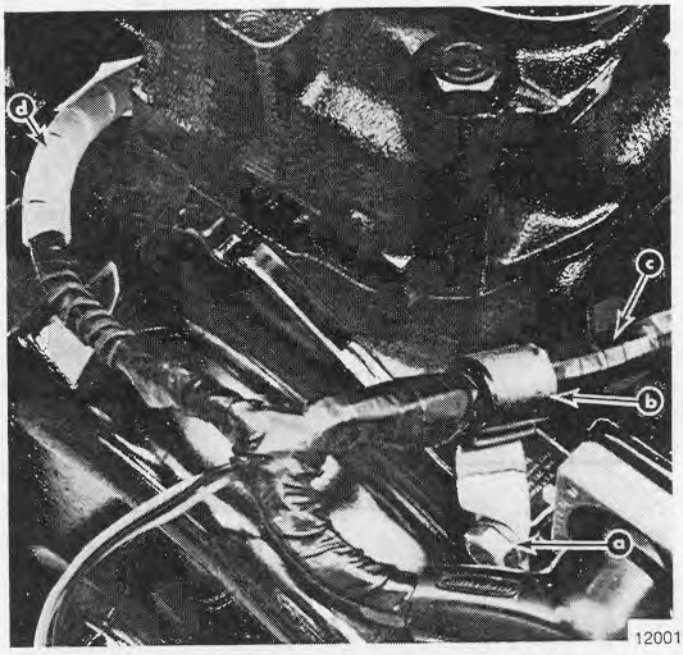
IMPORTANT: Be sure that wiring harness is positioned so that the harness protector is located between the flywheel housing and bottom edge of manifold. (Figure 2)

   b. Remove screw from flywheel housing (at the serial number plate) and install large J-clamp with 13/32" (10mm) attaching hole, as shown in Figure 2. Torque screw to 21 lbs. ft. (28 N.m). Route harness thru clamp and bend clamp shut.
   c. Remove screw from ignition coil mounting bracket and install medium J-clamp with 11/32" (9mm) attaching hole, as shown in Figure 3. Tighten screw securely. Route end of harness thru clamp and bend clamp shut. Position harness leads so that wires do not contact fuel line.



a - Wiring Harness b - J-Clamp (9/32" Attaching Hole)

Figure 1. Wiring Harness Fastened to Exhaust Manifold



a - Flywheel Housing Attaching Screw
b - J-Clamp (13/32" Attaching Hole)
c - Wiring Harness
d - Harness Protector

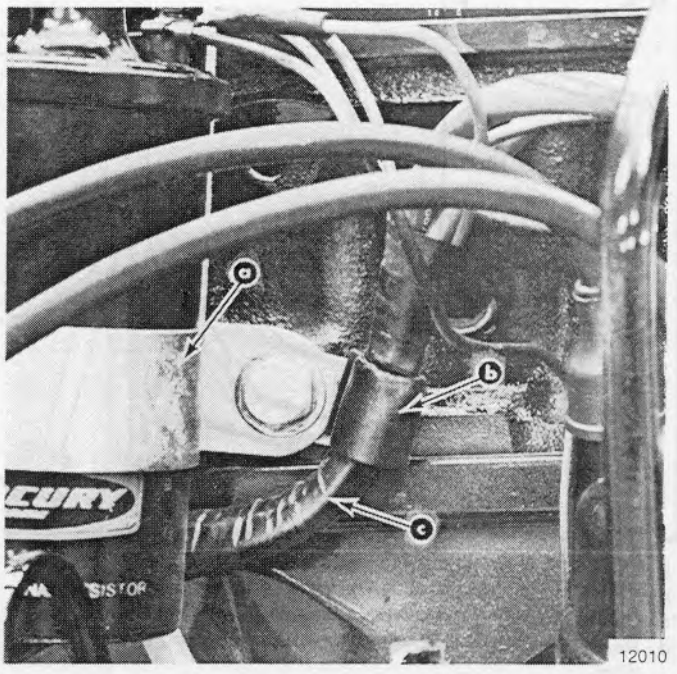
Figure 2. Wiring Harness Fastened to Flywheel Housing

4. If engine is equipped with a fuse on starter solenoid, remove (and discard) fuse.
5. Connect wiring harness leads to electrical components, as shown in Figure 4, being sure to complete the following:
   a. Position insulator boots over terminals on wires so equipped.
   b. Apply a coat of Liquid Neoprene to all terminal connections which are not protected by an insulator boot.
   c. Place heat shrink tubing (supplied with kit) over end of leads coming from alternator. Connect purple engine harness lead to purple (or white) alternator lead. Connect red-purple engine harness lead to red-purple (or red) alternator lead. Position heat shrink tubing over connections and heat with heat gun until secure.
   d. MCM engines, that are equipped with Delco single-wire alternators, do not use the purple and red-purple alternator leads (items "c" and "d" in Figure 4). On these engines, the purple and red-purple leads MUST BE insulated and taped back to wiring harness, as follows:
      1) Fold terminal on end of purple lead back against purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminal.
      2) Fold terminal on end of red-purple lead back against red-purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminals.
      3) Fold insulated purple and red-purple leads back against harness and secure with electrical tape.

⚠CAUTION

Failure to adequately insulate the purple and red-purple leads, as explained above, can result in electrical failure.

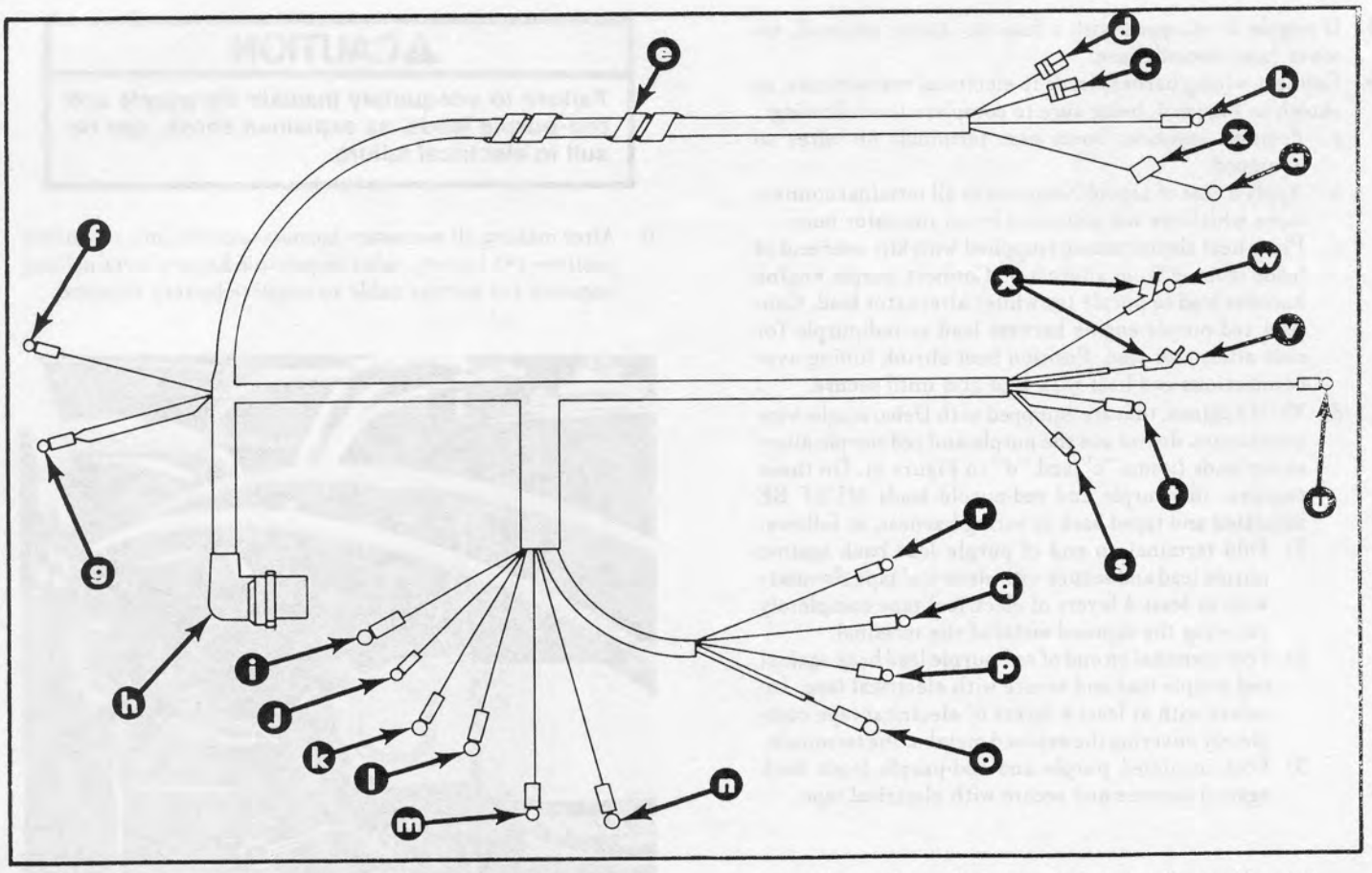
6. After making all necessary harness connections, reconnect positive (+) battery cable to positive battery terminal and negative (–) battery cable to negative battery terminal.



12010

a - Ignition Coil Mounting Bracket
b - J-Clamp (11/32" Attaching Hole)
c - Wiring Harness

Figure 3. Wiring Harness Fastened to Ignition Coil Mounting Bracket



a - Orange Wire - Connect to Alternator Output ("BAT") Terminal
b - Black Wire - Connect to Alternator Ground Terminal
*c - Purple Wire - Connect to Alternator Purple (or White) Wire
*d - Red-Purple Wire - Connect to Alternator Red-Purple (or Red) Wire
e - Harness Protector
f - Black Wire - Connect to Shift Interrupter Switch Terminal Block Mounting Screw
g - Gray Wire - Connect to Insulated Terminal on Shift Interrupter Switch Terminal Block
h - Receptacle
i - Black Wire - Connect to Flywheel Housing Attaching Screw on Starboard Side of Engine
j - Black Wire - Connect to Small Lower Terminal on Slave Solenoid
k - Red-Purple Wire - Connect to One Large Terminal on Slave Solenoid
l - Yellow-Red Wire - Connect to Other Large Terminal on Slave Solenoid
m - Yellow-Red Wire - Connect to Small Upper Terminal on Slave Solenoid
n - Brown-White Wire - Connect to Insulated Terminal on Trim Position Sender Terminal Block
o - Red Wire - Connect to Large Terminal on Starter Mounted Solenoid
p - Yellow-Red Wire - Connect to "S" Terminal on Starter Mounted Solenoid
q - Purple-Yellow Wire - Connect to "R" Terminal on Starter Mounted Solenoid
r - Light Blue Wire - Connect to Oil Pressure Sender on Side of Engine Block
s - Gray Wire - Connect to Negative (-) Terminal on Ignition Coil
t - Purple and Purple-Yellow Wires - Connect to Positive (+) Terminal on Ignition Coil
u - Tan Wire - Connect to Water Temperature Sender on Front of Thermostat Housing
v - Red Wire - Connect to Upper Terminal on Circuit Breaker
w - Red-Purple Wire - Connect to Lower Terminal on Circuit Breaker
x - Insulator Boot

**Install and shrink sleeve (supplied with harness) over these quick disconnect terminals. Be sure that all exposed metal on the terminals is covered.*

Figure 4. Wiring Harness (84-86673A2) Electrical Connections

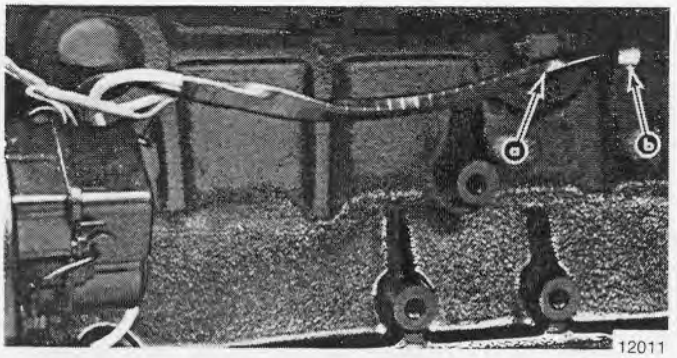
WIRING HARNESS KIT 84-86674A2
For MCM 165 Stern Drive Engine
INSTALLATION INSTRUCTIONS

NOTE: The fasteners, which are provided with this wiring harness, MUST BE used, as explained in the following instructions, when the harness is installed on MCM 165 Engines below Serial No. 5297841. Engines with Serial No. 5297841 and above already have the fasteners installed.

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

1. Remove (and discard) old wiring harness. Retain harness mounting plate and 4 attaching screws and all terminal fasteners.
2. Install wiring harness receptacle in wiring harness bracket and secure with mounting plate and 4 screws (retained in Step 1).
3. Route wiring harness and install fasteners provided with harness, as follows:
   a. Route section of harness (containing orange wire) to port side of engine. Remove ¼" screw from bottom of exhaust manifold and install J-clamp with 9/32" (7mm) attaching hole, as shown in Figure 1. Tighten screw securely. Route harness thru clamp and bend clamp shut.

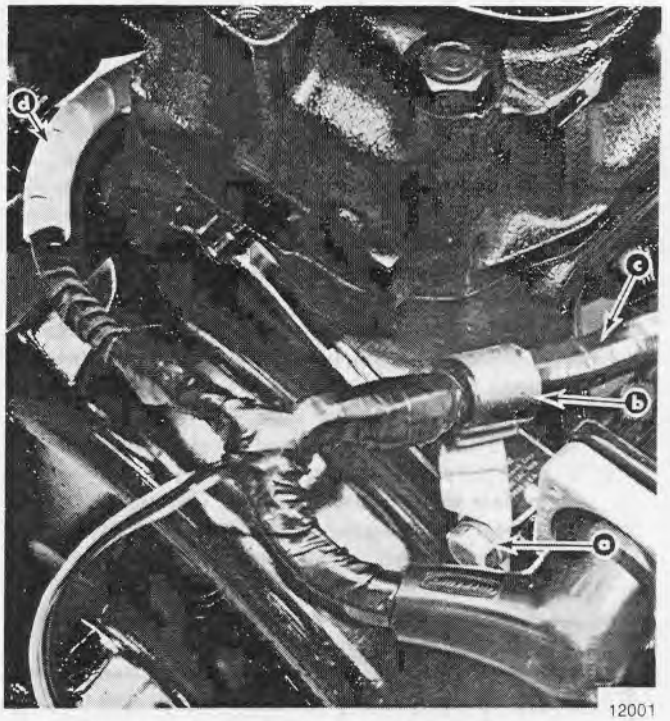


a - Wiring Harness b - J-Clamp (9/32" Attaching Hole)

Figure 1. Wiring Harness Fastened to Exhaust Manifold

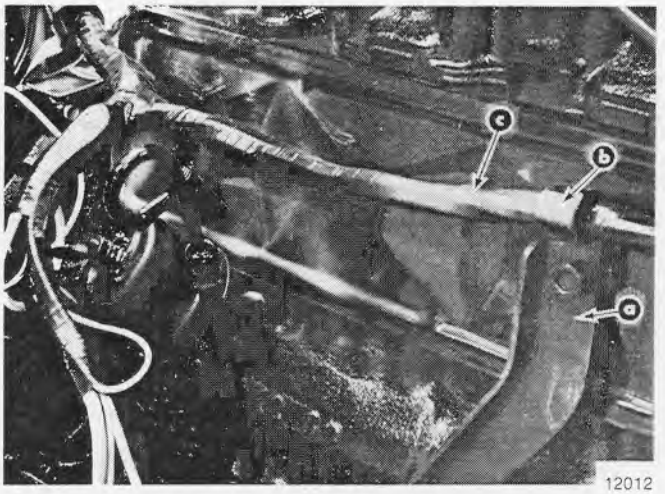
IMPORTANT: Be sure that wiring harness is positioned so that the harness protector is located between the flywheel housing and bottom edge of manifold. (Figure 2)

   b. Remove screw from flywheel housing (at the serial number plate) and install large J-clamp with 13/32" (10mm) attaching hole, as shown in Figure 2. Torque screw to 21 lbs. ft. (28 N.m). Route harness thru clamp and bend clamp shut.
   c. Remove nut, that secures starter brace to side of engine, and install smaller J-clamp with 13/32" attaching hole, as shown in Figure 3. Torque nut to 144 in. lbs. (16 N.m). Route harness thru J-clamp and bend clamp shut.



a - Flywheel Housing Attaching Screw c - Wiring Harness
b - J-Clamp (13/32" Attaching Hole) d - Harness Protector

Figure 2. Wiring Harness Fastened to Flywheel Housing



a - Starter Brace
b - J-Clamp (13/32" Attaching Hole)
c - Wiring Harness

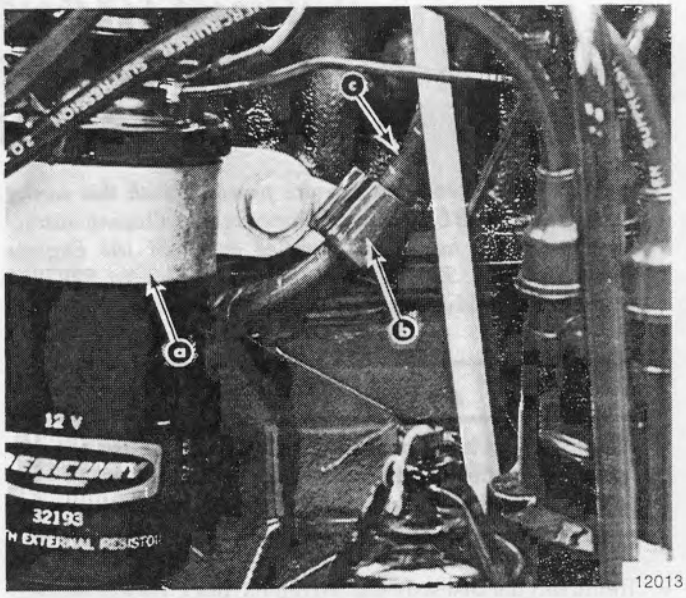
Figure 3. Wiring Harness Fastened to Starter Brace

   d. Remove screw from ignition coil mounting bracket and install J-clamp with 11/32" (9mm) attaching hole, as shown in Figure 4. Tighten screw securely. Route end of harness thru clamp and bend clamp shut. Position harness leads so that they do not contact fuel line.
4. If engine is equipped with a fuse on starter solenoid, remove (and discard) fuse.

5. Connect wiring harness leads to electrical components, as shown in Figure 4, being sure to complete the following:
   a. Position insulator boots over terminals on wires so equipped.
   b. Apply a coat of Liquid Neoprene to all terminal connections which are not protected by an insulator boot.
   c. Place heat shrink tubing (supplied with kit) over end of leads coming from alternator. Connect purple engine harness lead to purple (or white) alternator lead. Connect red-purple engine harness lead to red-purple (or red) alternator lead. Position heat shrink tubing over connections and heat with heat gun until secure.
   d. MCM engines, that are equipped with Delco single-wire alternators, do not use the purple and red-purple alternator leads (items "c" and "d" in Figure 5). On these engines, the purple and red-purple leads MUST BE insulated and taped back to wiring harness, as follows:
      1) Fold terminal on end of purple lead back against purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminal.
      2) Fold terminal on end of red-purple lead back against red-purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminals.
      3) Fold insulated purple and red-purple leads back against harness and secure with electrical tape.

⚠CAUTION

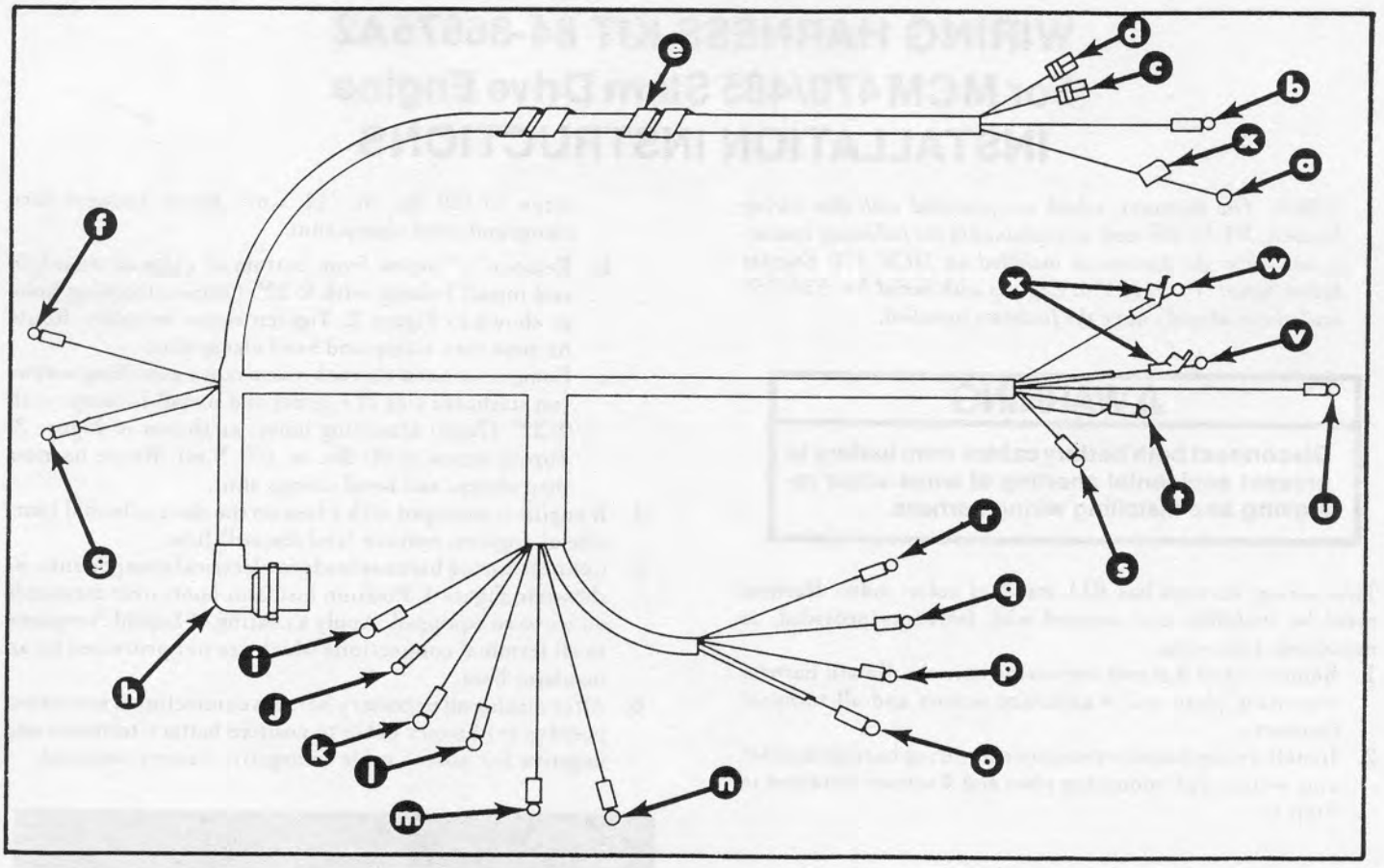
Failure to adequately insulate the purple and red-purple leads, as explained, can result in electrical failure.



a - Ignition Coil Mounting Bracket
b - J-Clamp (11/32" Attaching Hole)
c - Wiring Harness

Figure 4. Wiring Harness Fastened to Ignition Coil Mounting Bracket

6. After making all necessary harness connections, reconnect positive (+) battery cable to positive battery terminal and negative (-) battery cable to negative battery terminal.



a - Orange Wire - Connect to Alternator Output ("BAT") Terminal
b - Black Wire - Connect to Alternator Ground Terminal
*c - Purple Wire - Connect to Alternator Purple (or White) Wire
*d - Red-Purple Wire - Connect to Alternator Red-Purple (or Red) Wire
e - Harness Protector
f - Black Wire - Connect to Shift Interrupter Switch Terminal Block Mounting Screw
g - Gray Wire - Connect to Insulated Terminal on Shift Interrupter Switch Terminal Block
h - Receptacle
i - Black Wire - Connect to Flywheel Housing Attaching Screw on Starboard Side of Engine
j - Black Wire - Connect to Small Lower Terminal on Slave Solenoid
k - Red-Purple Wire - Connect to One Large Terminal on Slave Solenoid
l - Yellow-Red Wire - Connect to Other Large Terminal on Slave Solenoid
m - Yellow-Red Wire - Connect to Small Upper Terminal on Slave Solenoid
n - Brown-White Wire - Connect to Insulated Terminal on Trim Position Sender Terminal Block
o - Red Wire - Connect to Large Terminal on Starter Mounted Solenoid
p - Yellow-Red Wire - Connect to "S" Terminal on Starter Mounted Solenoid
q - Purple-Yellow Wire - Connect to "R" Terminal on Starter Mounted Solenoid
r - Light Blue Wire - Connect to Oil Pressure Sender on Side of Engine Block
s - Gray Wire - Connect to Negative (-) Terminal on Ignition Coil
t - Purple and Purple-Yellow Wires - Connect to Positive (+) Terminal on Ignition Coil
u - Tan Wire - Connect to Water Temperature Sender on Front of Thermostat Housing
v - Red Wire - Connect to Upper Terminal on Circuit Breaker
w - Red-Purple Wire - Connect to Lower Terminal on Circuit Breaker
x - Insulator Boot

**Install and shrink sleeve (supplied with harness) over these quick disconnect terminals. Be sure that all exposed metal on the terminals is covered.*

Figure 5. Wiring Harness (84-86674A2) Electrical Connections

WIRING HARNESS KIT 84-86675A2
For MCM 470/485 Stern Drive Engine
INSTALLATION INSTRUCTIONS

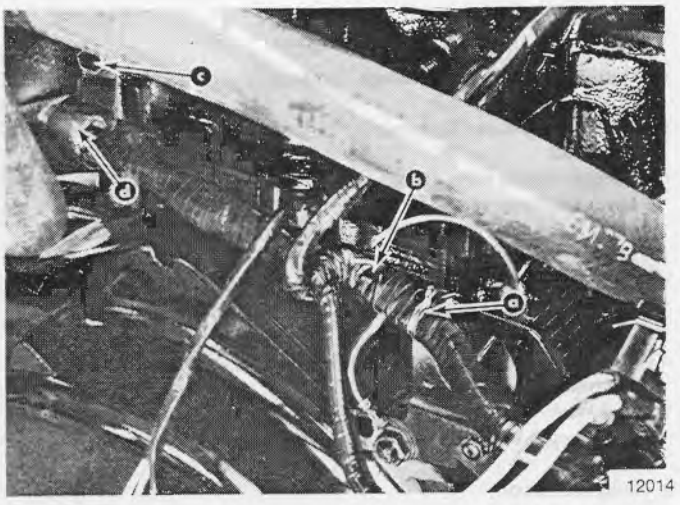
NOTE: The fasteners, which are provided with this wiring harness, MUST BE used, as explained in the following instructions, when the harness is installed on MCM 470 Engines below Serial No. 5319156. Engines with Serial No. 5319156 and above already have the fasteners installed.

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

This wiring harness has BIA standard color codes. Harness must be installed and secured with fasteners provided, as explained, following.

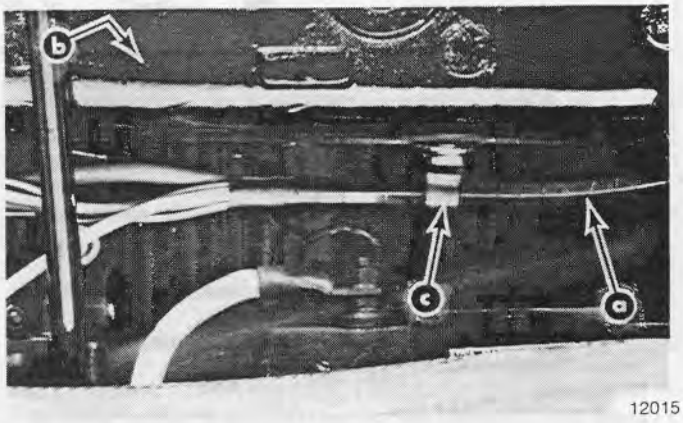
1. Remove (and discard) old wiring harness. Retain harness mounting plate and 4 attaching screws and all terminal fasteners.
2. Install wiring harness receptacle in wiring harness bracket and secure with mounting plate and 4 screws (retained in Step 1).



a - Sta-Strap
b - Wiring Harness
c - 3/8" Screw from Cylinder Head
d - J-Clamp (13/32" Attaching Hole)

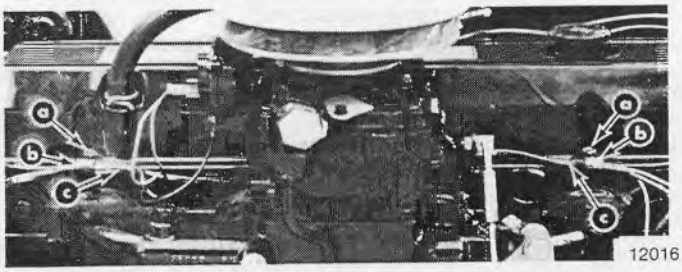
Figure 1. Wiring Harness Fastened to Flywheel Housing and Cylinder Head

3. Route wiring harness and install fasteners provided with harness, as follows:
   a. Route section of harness (containing orange wire) to port side of engine. Fasten harness (with sta-strap) to flywheel housing. (Figure 1) Remove ⅜" screw from aft end of cylinder head and install large J-clamp with 13/32" (10mm) attaching hole, as shown. Torque screw to 120 lbs. in. (14 N.m). Route harness thru clamp and bend clamp shut.
   b. Remove ¼" screw from bottom of exhaust manifold and install J-clamp with 9/32" (7mm) attaching hole, as shown in Figure 2. Tighten screw securely. Route harness thru clamp and bend clamp shut.
   c. Remove fore and aft rocker arm cover attaching screws (on starboard side of engine) and install J-clamps with 9/32" (7mm) attaching holes, as shown in Figure 3. Torque screw to 90 lbs. in. (10 N.m). Route harness thru clamps and bend clamps shut.
4. If engine is equipped with a fuse on the slave solenoid (port side of engine), remove (and discard) fuse.
5. Connect wiring harness leads to electrical components, as shown in Figure 4. Position insulator boots over terminals on wires so equipped. Apply a coating of Liquid Neoprene to all terminal connections which are not protected by an insulator boot.
6. After making all necessary harness connections, reconnect positive (+) battery cable to positive battery terminal and negative (-) battery cable to negative battery terminal.



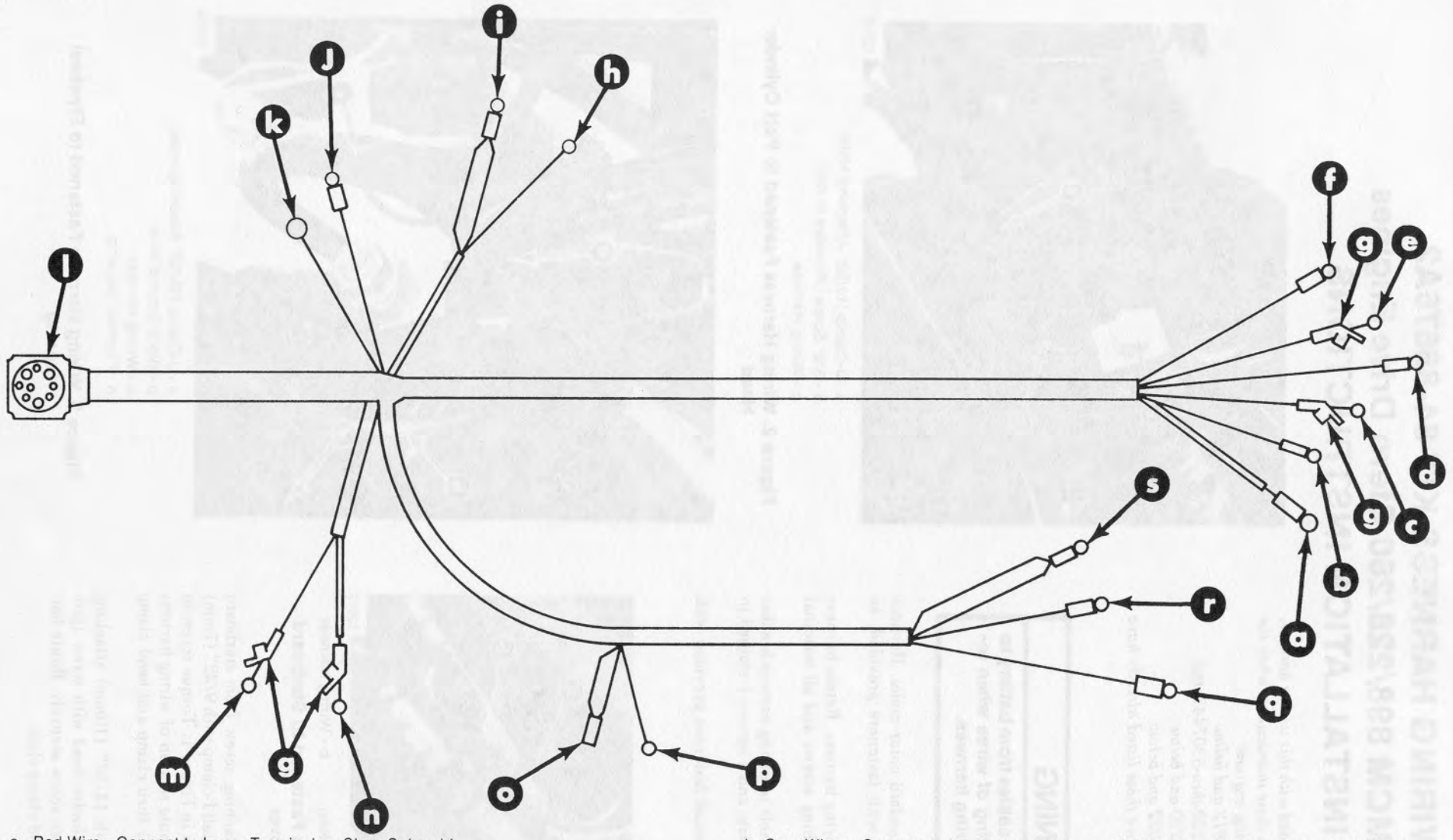
a - Wiring Harness
b - Exhaust Manifold
c - J-Clamp (9/32" Attaching Hole)

Figure 2. Wiring Harness Fastened to Manifold



a - Rocker Arm Cover Attaching Screws
b - J-Clamps (9/32" Attaching Hole)
c - Wiring Harness

Figure 3. Wiring Harness Fastened to Rocker Arm Cover



a - Red Wire - Connect to Large Terminal on Slave Solenoid
[Same Terminal to Which Positive (+) Battery Cable Is Connected]
b - Yellow-Red Wire - Connect to "S" Terminal on Slave Solenoid
c - Red-Purple Wire - Connect to Red "Sense" Terminal on Voltage Regulator
(Air-Cooled Regulator - Tape Back)
d - Tan Wire - Connect to Water Temperature Sender on Side of Thermostat Housing
e - Orange Wire - Connect to Output Terminal on Voltage Regulator
(Air-Cooled Regulator - To Rectifier)
f - Purple-Yellow Wire - Connect to "I" Terminal on Slave Solenoid
g - Insulator Boot
h - Black Wire - Connect to Shift Interrupter Switch Terminal Block Mounting Screw
i - Gray Wires - Connect to Insulated Terminal on Shift Interrupter Switch Terminal Block
j - Brown-White Wire - Connect to Insulated Terminal on Trim Position Sender Terminal Block
k - Black Wire - Connect to Flywheel Housing Attaching Screw on Starboard Side of Engine
l - Receptacle
m - Red-Purple Wire - Connect to One Circuit Breaker Terminal
n - Red Wire - Connect to Other Circuit Breaker Terminal
o - Purple Wires with Push-On Connection - Connect to Terminal on Choke Housing Assembly
p - Black Wire - Connect to Bottom Choke Cover Screw
q - Light Blue Wire - Connect to Oil Pressure Sender on Starboard Side of Engine
r - Gray Wire - Connect to Negative (-) Terminal on Ignition Coil
s - Purple and Purple-Yellow Wire - Connect to Positive (+) Terminal on Ignition Coil

Figure 4. Wiring Harness (84-86675A2) Electrical Connections

WIRING HARNESS KIT 84-86676A2
For MCM 898/228/260 Stern Drive Engines
INSTALLATION INSTRUCTIONS

NOTE: Fasteners, that are provided with this wiring harness, MUST BE used, as explained in these instructions, when the harness is installed on the following engines:

MCM 898 - Serial No. 5290812 and below
MCM 228 - Serial No. 5307218-thru-5307447 and Serial No. 5307210 and below
MCM 260 - Serial No. 5375022 and below

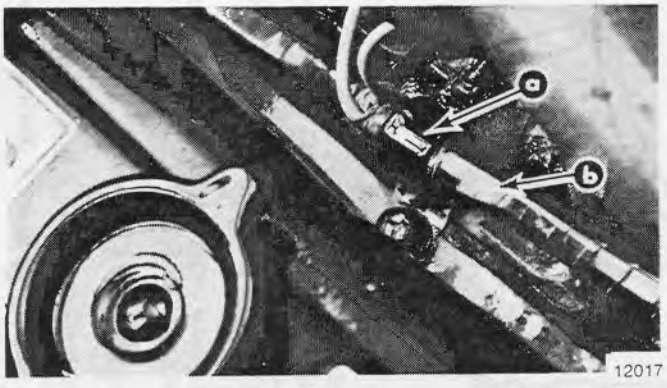
Engines with serial numbers above those listed already have the fasteners installed.

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

This wiring harness has BIA standard color codes. Harness must be installed and secured with fasteners provided, as explained, following.

1. Remove (and discard) old wiring harness. Retain harness mounting plate and 4 attaching screws and all terminal fasteners.
2. Install wiring harness receptacle in wiring harness bracket and secure with mounting plate and 4 screws (retained in Step 1).
3. Route wiring harness and install fasteners provided with harness, as follows:

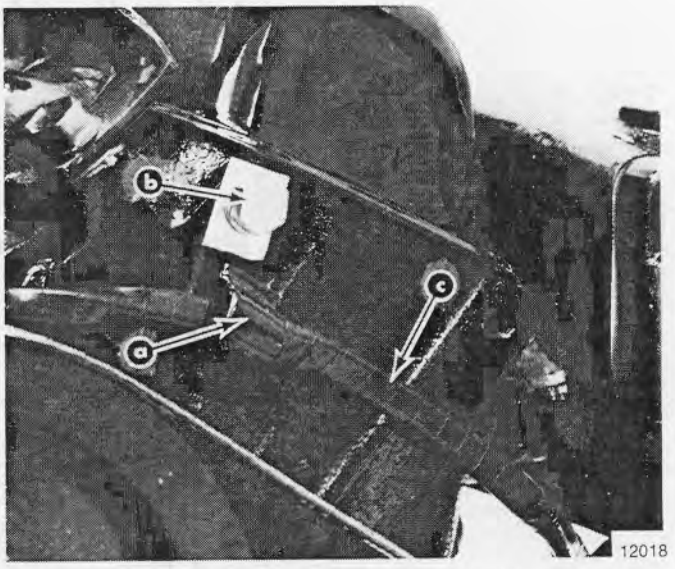


a - J-Clamp (9/32" Attaching Hole) b - Wiring Harness

Figure 1. Wiring Harness Fastened to Starboard Rocker Arm Cover

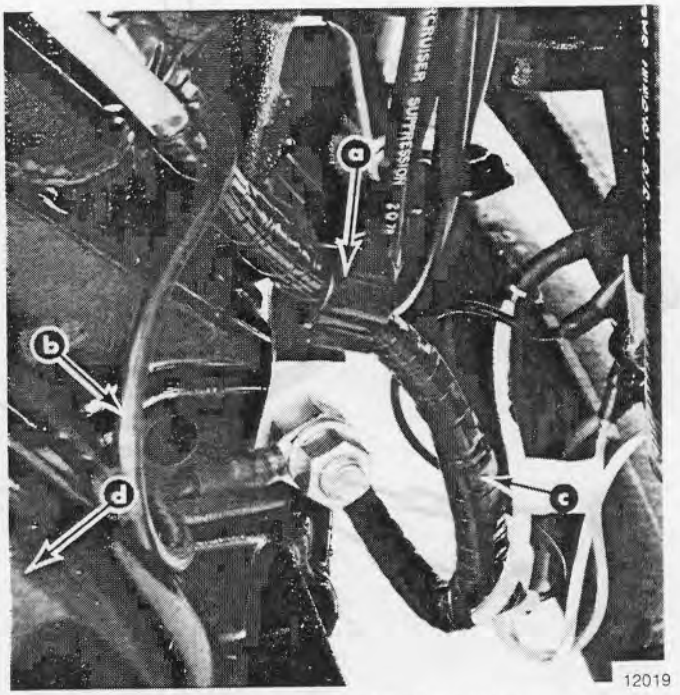
a. Remove upper front attaching screw from starboard rocker arm cover and install J-clamp with 9/32" (7mm) attaching hole, as shown in Figure 1. Torque screw to 48 in. lbs. (5.4 N.m). Route section of wiring harness (containing orange wire) thru clamp and bend clamp shut.

b. Install large J-clamp with 13/32" (10mm) attaching hole to front of port cylinder head with screw (provided). (Figure 2) Tighten screw securely. Route harness thru clamp and bend clamp shut.



a - J-Clamp (13/32" Attaching Hole)
b - 3/8" Screw (Provided in Kit)
c - Wiring Harness

Figure 2. Wiring Harness Fastened to Port Cylinder Head



a - J-Clamp (13/32" Attaching Hole)
b - Black Ground Wire
c - Wiring Harness
d - Flywheel Housing

Figure 3. Wiring Harness Fastened to Flywheel Housing

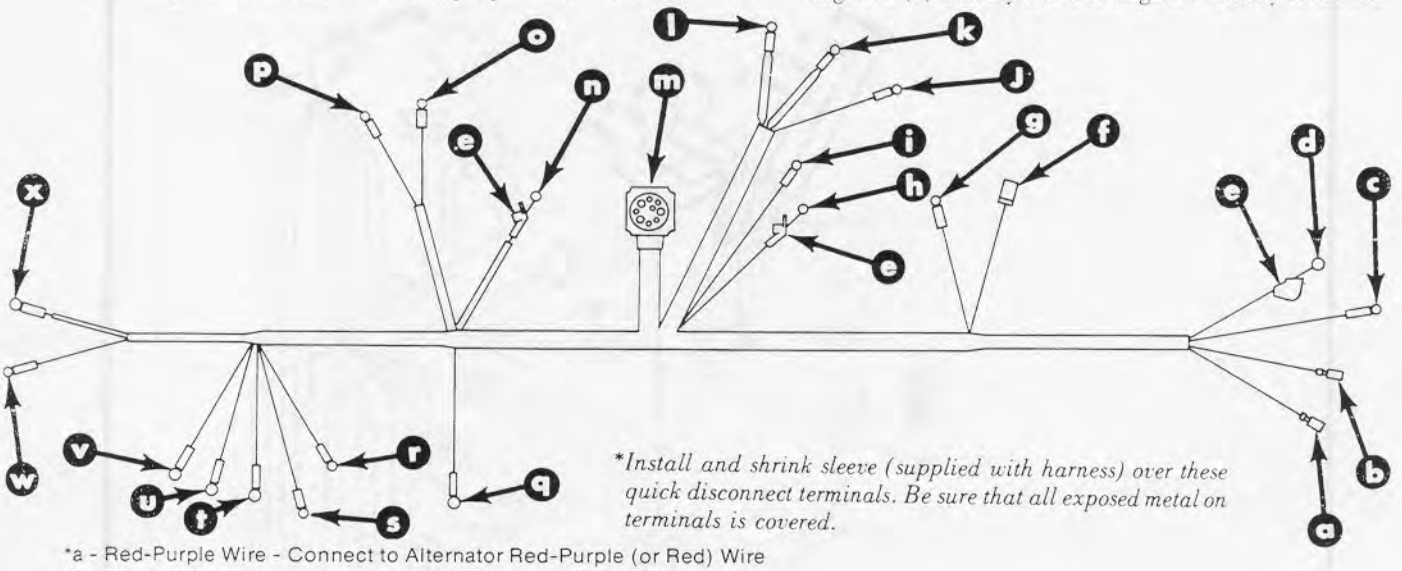
c. Remove flywheel housing attaching nut (some engines may have a screw) and install large J-clamp with 13/32" attaching hole and black ground wire, as shown in Figure 3. Torque nut (or screw) to 30 ft. lbs. (41 N.m). Route harness thru clamp and bend clamp shut.

4. If engine is equipped with fuse on starter solenoid, remove (and discard) fuse.
5. Connect wiring harness leads to electrical components, as shown in Figure 4, being sure to complete the following:
   a. Position insulator boots over terminals on wires so equipped.
   b. Apply a coat of Liquid Neoprene to all terminal connections which are not protected by an insulator boot.
   c. Place heat shrink tubing (supplied with kit) over end of leads coming from alternator. Connect purple engine harness lead to purple (or white) alternator lead. Connect red-purple engine harness lead to red-purple (or red) alternator lead. Position heat shrink tubing over connections and heat with heat gun until secure.
   d. MCM engines, that are equipped with Delco single-wire alternators, DO NOT USE the purple and red-purple alternator leads (items "a" and "b" in Figure 4). On these engines, the purple and red-purple leads MUST BE insulated and taped back to wiring harness, as follows:
      1) Fold terminal on end of purple lead back against purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminal.
      2) Fold terminal on end of red-purple lead back against red-purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminals.
      3) Fold insulated purple and red-purple leads back against harness and secure with electrical tape.

⚠CAUTION

Failure to adequately insulate the purple and red-purple leads, as explained above, can result in electrical failure.

6. After making all necessary harness connections, reconnect positive (+) battery cable to positive battery terminal and negative (-) battery cable to negative battery terminal.



**Install and shrink sleeve (supplied with harness) over these quick disconnect terminals. Be sure that all exposed metal on terminals is covered.*

*a - Red-Purple Wire - Connect to Alternator Red-Purple (or Red) Wire
*b - Purple Wire - Connect to Alternator Purple (or White) Wire
c - Black Wire - Connect to Alternator Ground Terminal
d - Orange Wire - Connect to Alternator ("BAT") Output Terminal
e - Insulator Boot
f - Purple Wire - on MCM 898, Connect to Terminal on Choke Housing Assembly; on All Other Models, Tape Back to Harness and Insulate with at Least 4 Layers of Electrical Tape (Completely Covering Exposed Metal of Terminal)
g - Tan Wire - Connect to Water Temperature Sender Near Thermostat Housing on Starboard Side of Intake Manifold
h - Red-Purple Wire - Connect to Circuit Breaker Terminal Closest to Receptacle
i - Brown-White Wire - Connect to Insulated Terminal on Trim Position Sender Terminal Block
j - Light Blue Wire - Connect to Oil Pressure Sender on Aft End of Engine
k - Purple-Yellow and Purple Wires - Connect to Positive (+) Terminal on Ignition Coil
l - Gray Wires - Connect to Negative (-) Terminal on Ignition Coil
m - Receptacle
n - Red Wire - Connect to Circuit Breaker Terminal Furthest away from Receptacle
o - Black Wire - Connect to Shift Interrupter Switch Terminal Block Mounting Screw
p - Gray Wire - Connect to Shift Interrupter Switch Terminal Block
q - Black Wire - Connect to Flywheel Housing Attaching Screw on Starboard Side of Engine
r - Purple-Yellow Wire - Connect to "I" Terminal on Slave Solenoid
s - Yellow-Red Wire - Connect to "S" Terminal on Slave Solenoid
t - Black Wire - Connect to Slave Solenoid Mounting Bracket
u - Yellow-Red Wire - Connect to One Large Terminal on Slave Solenoid
v - Red-Purple Wire - Connect to Other Large Terminal on Slave Solenoid
w - Red-Yellow Wire - Connect to "S" Terminal on Starter Mounted Solenoid
x - Red Wire - Connect to Large Terminal on Starter Mounted Solenoid

Figure 4. Wiring Harness (84-86676A2) Electrical Connections

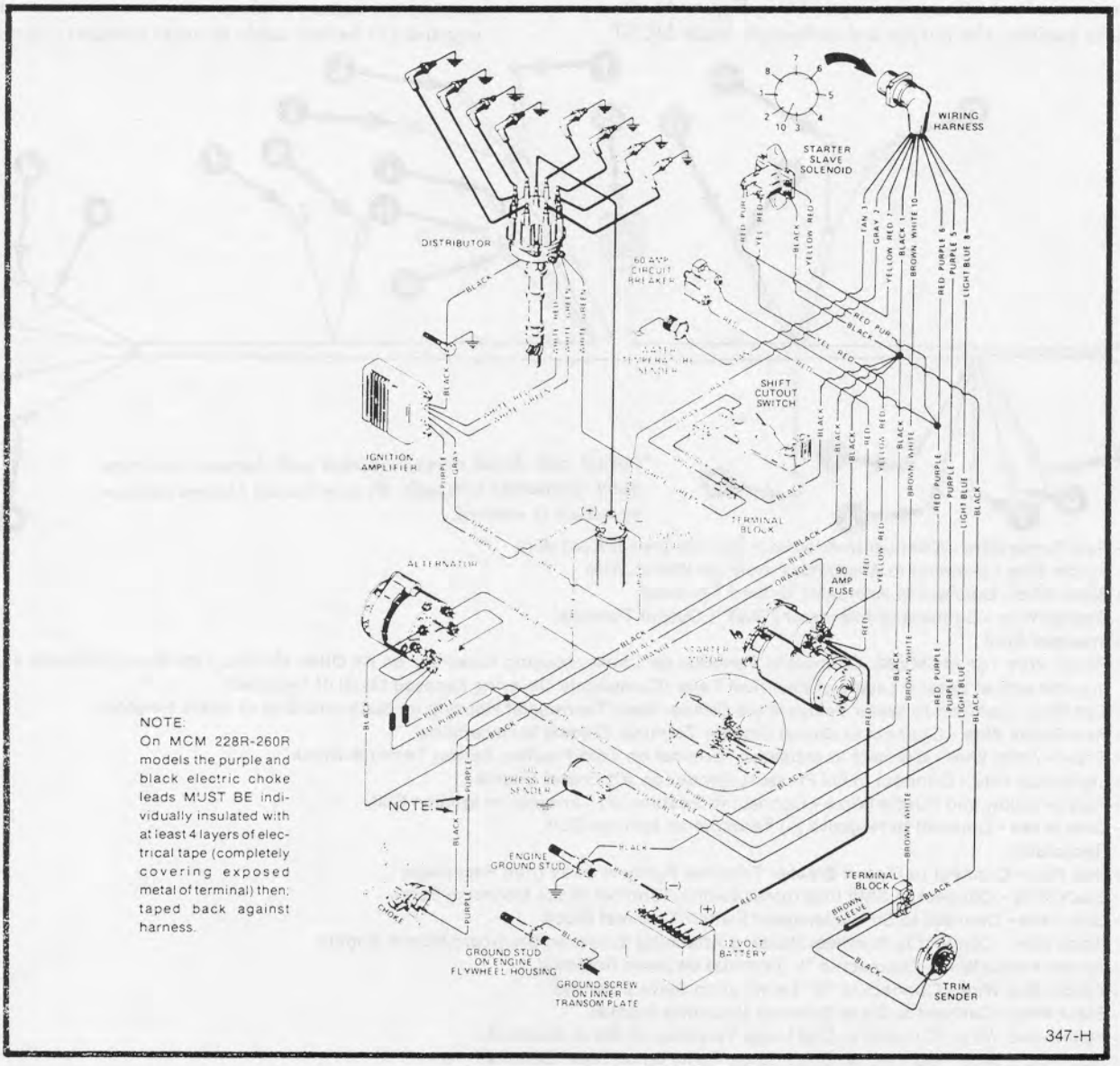
WIRING HARNESS KIT 84-98423A4
For MCM 898R/228R/260R Stern Drive Engines
INSTALLATION INSTRUCTIONS

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

Install wiring harness, as shown, being sure to observe the following:

- Be sure that all 'J''-clamps, which secure wiring harness, are bent shut.
- Install heat shrink tubing over the quick disconnect terminals at alternator. Be sure that all exposed metal on terminals is covered.
- Position insulator boots over terminals on wires so equipped.
- Apply a thin coat of Quicksilver Liquid Neoprene (92-25711) to all terminal connections which are not protected by an insulator boot.
- On MCM 228R-260R models the purple and black electric choke leads MUST BE individually insulated with at least 4 layers of electrical tape (completely covering exposed metal of terminal) then; taped back against harness.



NOTE:
On MCM 228R-260R models the purple and black electric choke leads MUST BE individually insulated with at least 4 layers of electrical tape (completely covering exposed metal of terminal) then; taped back against harness.

WIRING HARNESS KIT 84-86683A2
For MCM 330 Stern Drive Engine
INSTALLATION INSTRUCTIONS

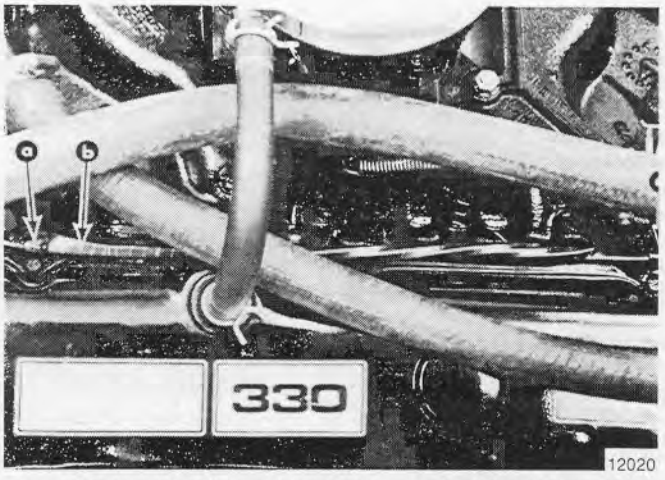
NOTE: The fasteners, which are provided with this wiring harness, MUST BE used, as explained in the following instructions, when the harness is installed on MCM 330 Engines below Serial No. 5354658. Engines with Serial No. 5354658 and above already have the fasteners installed.

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

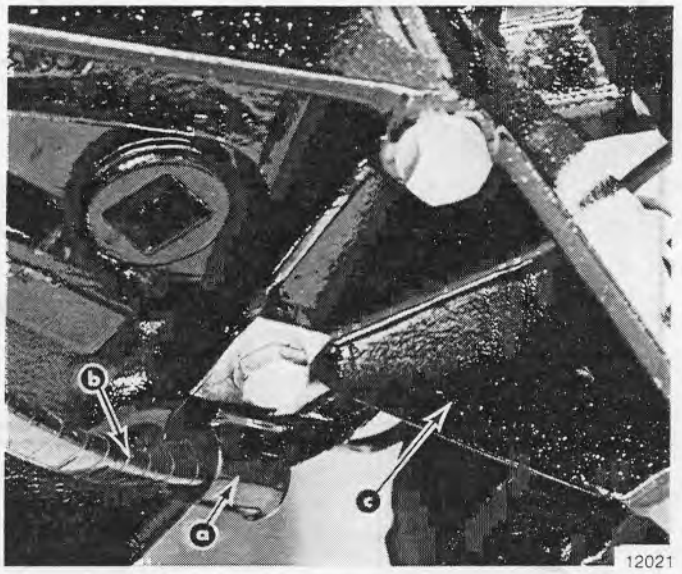
This wiring harness has BIA standard color codes. Harness must be installed and secured with fasteners provided, as explained, following.

1. Remove (and discard) old wiring harness. Retain harness mounting plate and 4 attaching screws and all terminal fasteners.
2. Install wiring harness receptacle in wiring harness bracket and secure with mounting plate and 4 screws (retained in Step 1).
3. Route wiring harness and install fasteners provided with harness, as follows:
   a. Remove screws from rocker arm cover (on port side of engine) and install J-clamps with 9/32" (7mm) attaching hole, as shown in Figure 1. Torque screws to 48 in. lbs. (5.4 N.m). Route long section of harness thru clamps and bend clamps shut.
   b. Remove bottom attaching screw from alternator bracket and install J-clamp with 13/32" (10mm) attaching hole, as shown in Figure 2. Torque screw to 25 ft. lbs. (34 N.m). Route end of harness thru clamp to alternator and bend clamp shut.



a - J-Clamps (9/32" Attaching Hole) b - Wiring Harness

Figure 1. Wiring Harness Fastened to Port Rocker Arm Cover



a - J-Clamp (13/32" Attaching Hole)
b - Wiring Harness
c - Alternator Bracket

Figure 2. Wiring Harness Fastened to Alternator Bracket

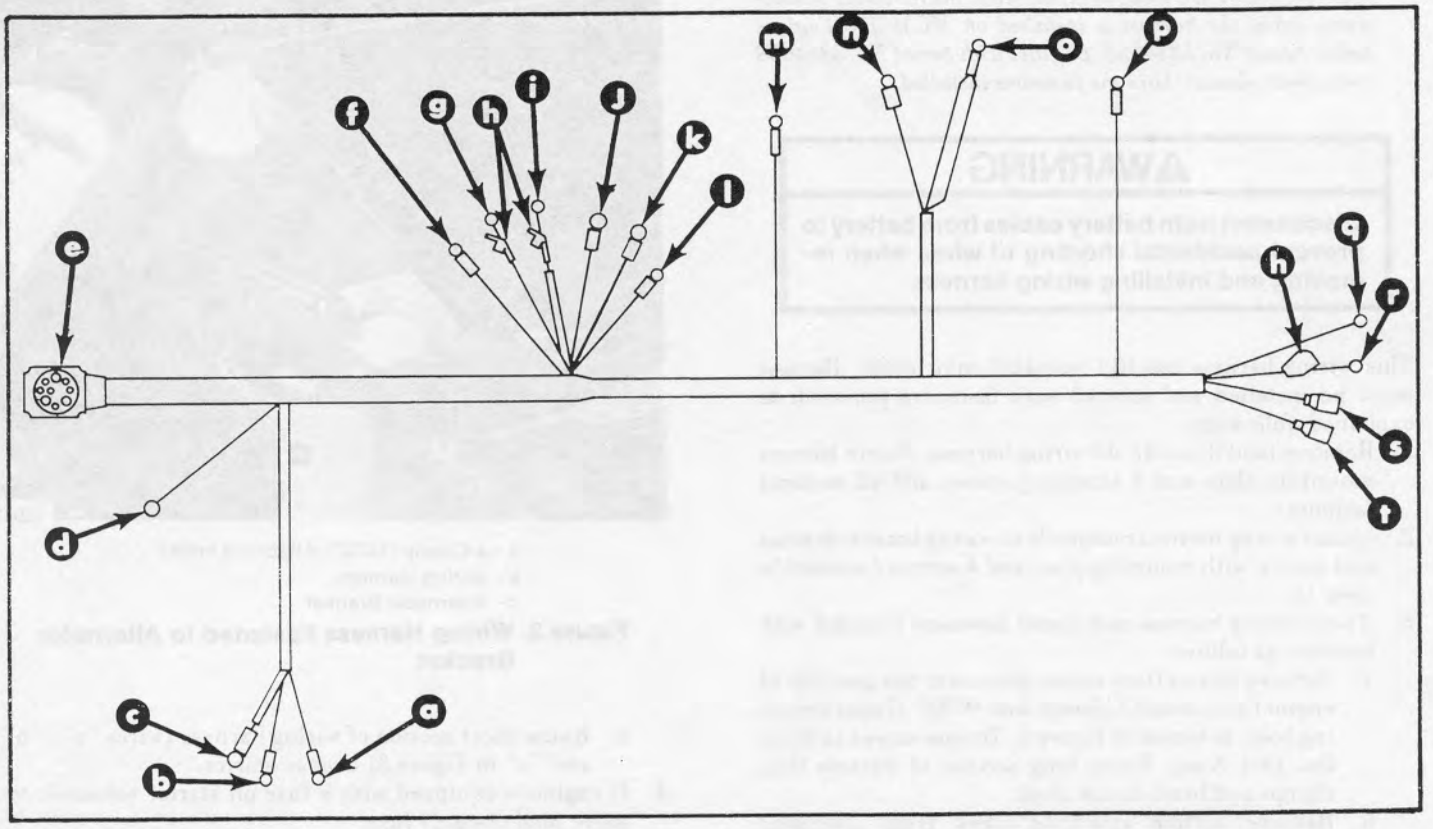
   c. Route short section of wiring harness (wires "a", "b" and "c" in Figure 3) over to starter.
4. If engine is equipped with a fuse on starter solenoid, remove (and discard) fuse.
5. Connect wiring harness leads to electrical components, as shown in Figure 3, being sure to complete the following:
   a. Position insulator boots over terminals on wires so equipped.
   b. Apply a coat of Liquid Neoprene to all terminal connections which are not protected by an insulator boot.
   c. Place heat shrink tubing (supplied with kit) over end of leads coming from alternator. Connect purple engine harness lead to purple (or white) alternator lead. Connect red-purple engine harness lead to red-purple (or red) alternator lead. Position heat shrink tubing over connections and heat with heat gun until secure.
   d. MCM engines, that are equipped with Delco single-wire alternators, do not use the purple and red-purple alternator leads (items "s" and "t" in Figure 3). On these engines, the purple and red-purple leads MUST BE insulated and taped back to wiring harness, as follows:
      1) Fold terminal on end of purple lead back against purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminal.
      2) Fold terminal on end of red-purple lead back against red-purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminals.

⚠CAUTION

Failure to adequately insulate the purple and red-purple leads, as explained in 1), 2), 3), preceding, can result in electrical failure.

3) Fold insulated purple and red-purple leads back against harness and secure with electrical tape.

6. After making all necessary harness connections, reconnect positive (+) battery cable to positive battery terminal and negative (–) battery cable to negative battery terminal.



a - Yellow-Red Wire - Connect to "S" Terminal on Starter Mounted Solenoid
b - Purple-Yellow Wire - Connect to "R" Terminal on Starter Mounted Solenoid
c - Red Wire - Connect to Large Terminal on Starter Mounted Solenoid
d - Black Wire - Connect to Flywheel Housing Attaching Screw on Starboard Side of Engine
e - Receptacle
f - Brown-White Wires - Connect to Insulated Terminal on Trim Position Sender Terminal Block
g - Red-Purple Wire - Connect to Upper Terminal on Circuit Breaker
h - Insulator Boot
i - Red Wire - Connect to Lower Terminal on Circuit Breaker
j - Red-Purple Wire - Connect to One Large Terminal on Slave Solenoid
k - Yellow-Red Wire - Connect to Other Large Terminal on Slave Solenoid
l - Yellow-Red Wire - Connect to Small Lower Terminal on Slave Solenoid
m - Light Blue Wire - Connect to Oil Pressure Sender on Port Side of Engine
n - Gray Wire - Connect to Negative (–) Terminal on Ignition Coil
o - Purple-Yellow and Purple Wires - Connect to Positive (+) Terminal on Ignition Coil
p - Tan Wire - Connect to Water Temperature Sender on Starboard Side of Intake Manifold near Thermostat Housing
q - Black Wire - Connect to Alternator Ground Terminal
r - Orange Wire - Connect to Alternator Output ("BAT") Terminal
*s - Purple Wire - Connect to Alternator Purple (or White) Wire
*t - Red-Purple Wire - Connect to Alternator Red-Purple (or Red) Wires

**Install and shrink sleeves (supplied with harness) over these quick disconnect terminals. Be sure that all exposed metal on the terminals is covered.*

Figure 3. Wiring Harness (84-86683A2) Electrical Connections

WIRING HARNESS KIT 84-86677A2
For MIE 228/255/330 Inboard Engines
INSTALLATION INSTRUCTIONS

NOTE: The fasteners, which are provided with this wiring harness, MUST BE used, as explained in the following instructions, when the harness is installed on the following engines:

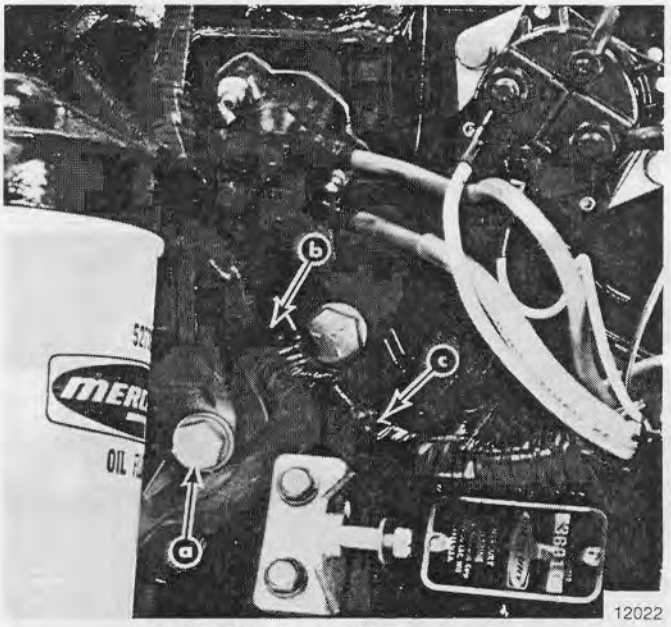
MIE 228 - Serial No. 5263525 and below
MIE 255 - Serial No. 5325249 and below
MIE 330 [R.H. (Opposite) Rotation] - 5300499 and below
MIE 330 [L.H. (Standard) Rotation] - 5369093 and below

Engines with serial numbers above those listed, already have the fasteners installed.

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

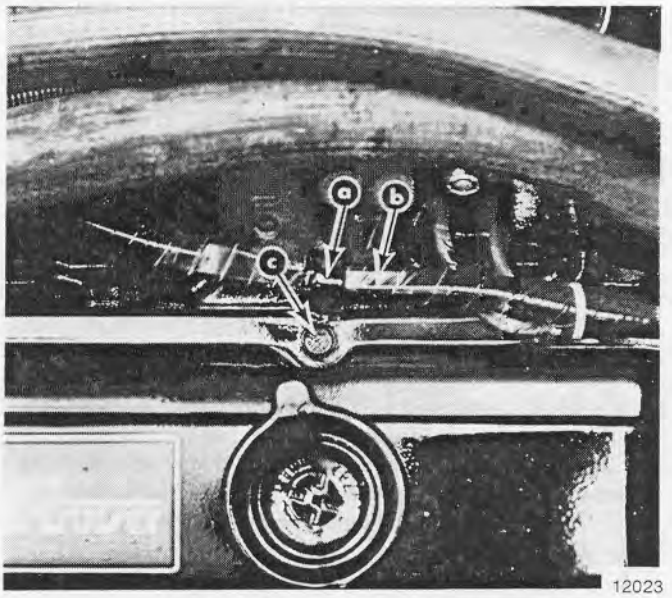
1. Remove (and discard) old wiring harness. Retain harness mounting plate and 4 attaching screws and all terminal fasteners.



a - Oil Filter Mounting Bracket Screw
b - J-Clamp (13/32" Attaching Hole) c - Wiring Harness

Figure 1. Wiring Harness Fastened to Oil Filter Bracket

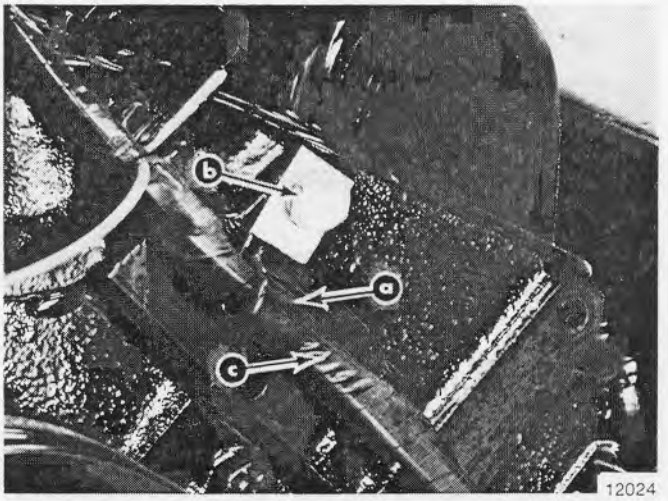
2. Install wiring harness receptacle in wiring harness bracket and secure with mounting plate and 4 screws (retained in Step 1).
3. Route wiring harness and install fasteners provided with harness, as follows:
   a. MIE 228/255 Engine
      1) Remove oil filter mounting bracket screw and install large J-clamp with 13/32" (10mm) attaching hole, as shown in Figure 1. Torque screw securely. Route long section of harness thru clamp and bend clamp shut.



a - J-Clamp (9/32" Attaching Hole)
b - Wiring Harness c- Rocker Arm Cover Screw

Figure 2. Wiring Harness Fastened to Port Rocker Arm Cover

      2) Remove rear attaching screw from port rocker arm cover and install J-clamp with 9/32" (7mm) attaching hole, as shown in Figure 2. Torque screw to 48 in. lbs. (5.4 N.m). Route harness thru clamp and bend clamp shut.
      3) Install smaller J-clamp with 13/32" (10mm) attaching hole to front of port cylinder head with screw (provided), as shown in Figure 3. Tighten screw securely. Route harness thru clamp and bend clamp shut.



a - J-Clamp (13/32" Attaching Hole)
b - 3/8" Fastening Screw (Provided in Kit) c- Wiring Harness

Figure 3. Wiring Harness Fastened to Port Cylinder Head

NOTE: Remainder of fasteners are not required for MerCruiser 228/255 Inboard Engines.

b. MIE 330 Engine
   1) Remove oil filter mounting bracket screw and install large J-clamp with 13/32" (10mm) attaching hole, as shown in Figure 1. Tighten screw securely. Route long section of harness thru clamp and bend clamp shut.
   2) Remove attaching screw from port rocker arm valve cover and install J-clamp with 9/32" (7mm) attaching hole, as shown in Figure 4. Torque screw to 48 in. lbs. (5.4 N.m). Route harness thru clamp and bend clamp shut.
   3) Secure wiring harness to water inlet hose with sta-strap (provided), as shown in Figure 5.

NOTE: Remainder of fasteners are not required for MIE 330 Engine.

4. If engine is equipped with a fuse on starter solenoid, remove (and discard) fuse.
5. Connect wiring harness leads to electrical components, as shown in Figure 6, being sure to complete the following:
   a. Position insulator boots over terminals on wires so equipped.
   b. Apply a coat of Liquid Neoprene to all terminal connections which are not protected by an insulator boot.
   c. Place heat shrink tubing (supplied with kit) over end of leads coming from alternator. Connect purple engine harness lead to purple (or white) alternator lead. Connect red-purple engine harness lead to red-purple (or red) alternator lead. Position heat shrink tubing over connections and heat with heat gun until secure.
   d. MerCruiser engines, that are equipped with Delco single-wire alternators, DO NOT use the purple and red-purple alternator leads (items "u" and "v" in Figure 6). On these engines, the purple and red-purple leads MUST BE insulated and taped back to wiring harness, as follows:
      1) Fold terminal on end of purple lead back against purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminal.
      2) Fold terminal on end of red-purple lead back against red-purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminals.
      3) Fold insulated purple and red-purple leads back against harness and secure with electrical tape.

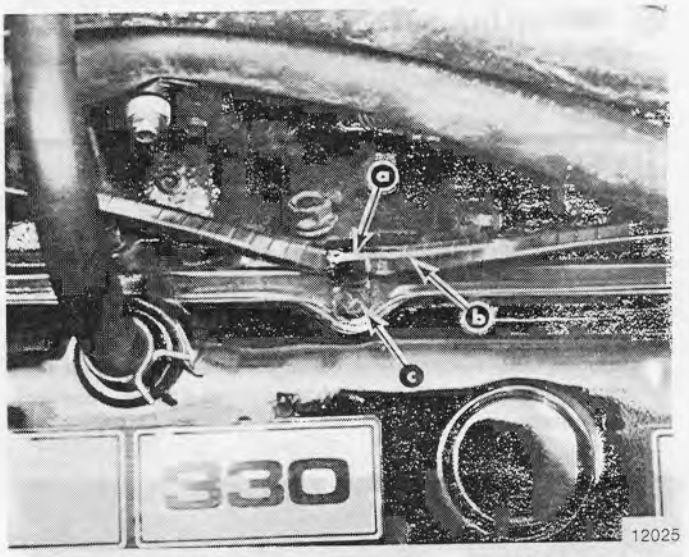
a - Inlet Water Hose b - Sta-Strap c - Wiring Harness

Figure 5. Wiring Harness Fastened to Water Inlet Hose

⚠CAUTION

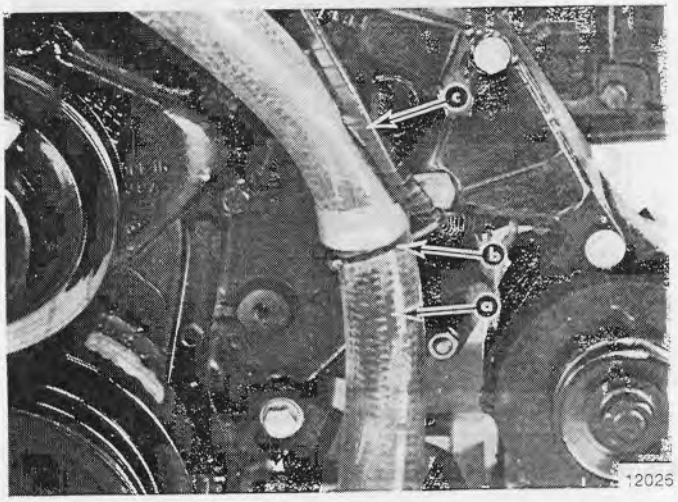
Failure to adequately insulate the purple and red-purple leads, as explained, can result in electrical failure.

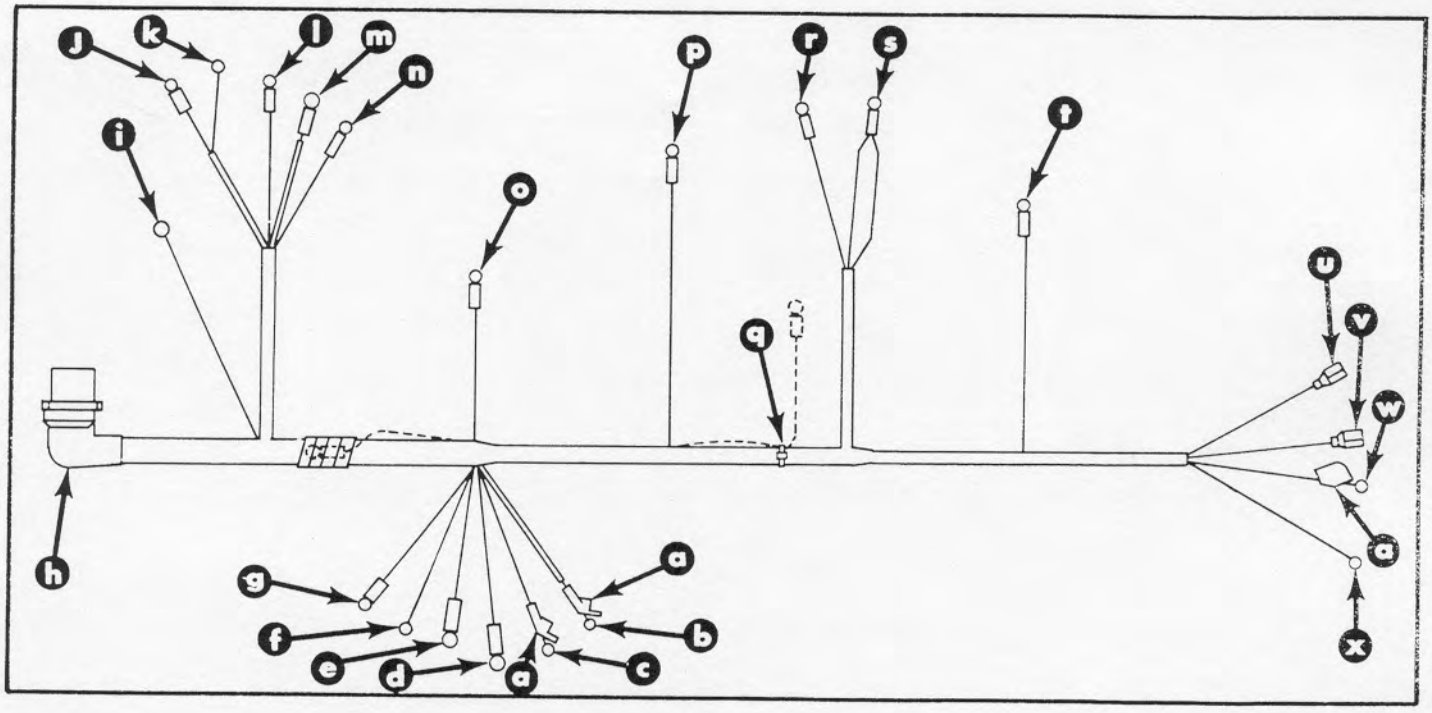
6. After making all necessary harness connections, reconnect positive (+) battery cable to positive battery terminal and negative (-) battery cable to negative battery terminal.



a - J-Clamp (9/32" Attaching Hole) b - Wiring Harness
c - Rocker Arm Cover Screw

Figure 4. Wiring Harness Fastened to Port Rocker Arm Cover





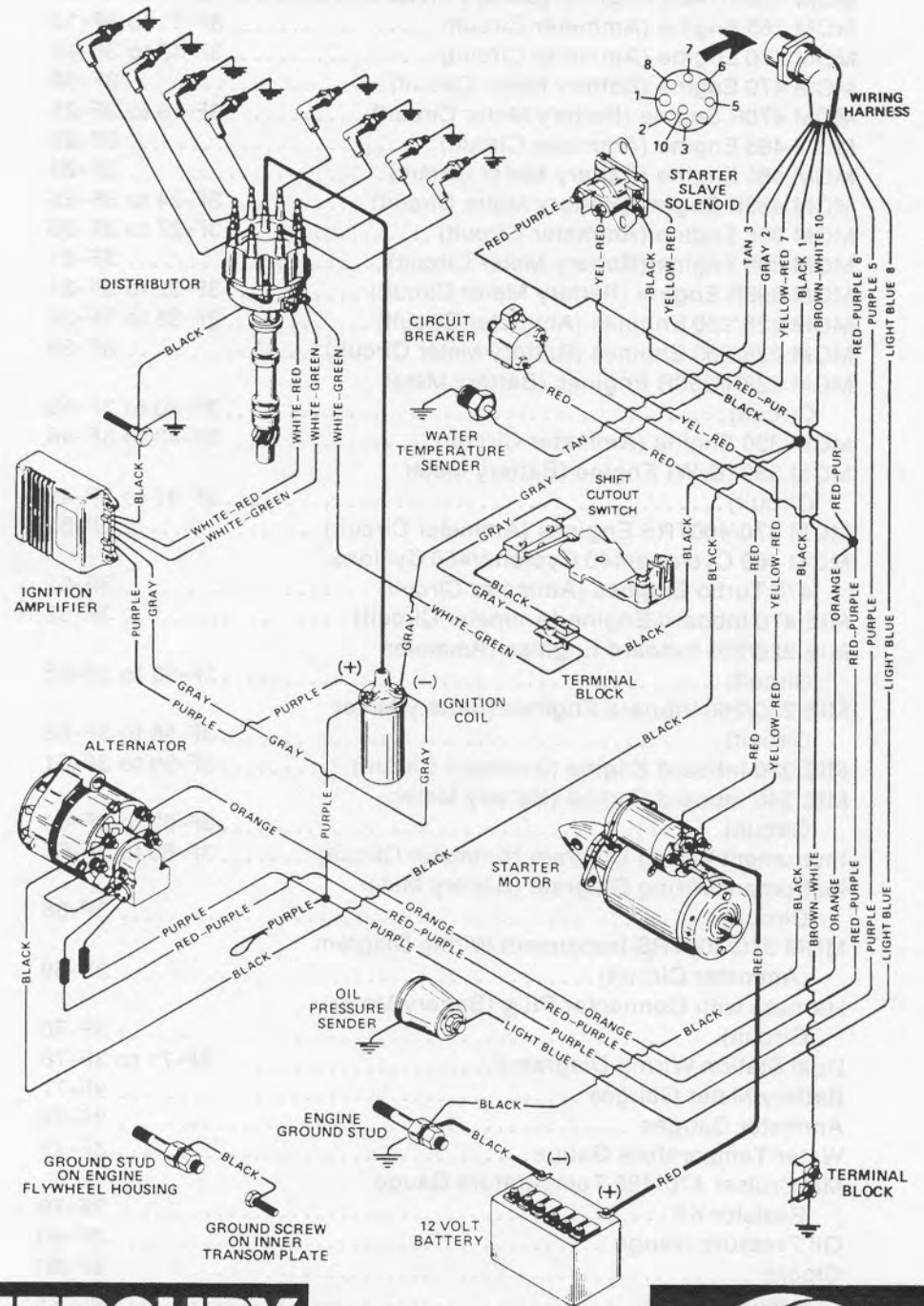
a - Insulator Boots
b - Red Wire - Connect to Lower Terminal on Circuit Breaker
c - Red-Purple Wire - Connect to Upper Terminal on Circuit Breaker
d - Yellow-Red Wire - Connect to One of the Large Terminals on Slave Solenoid
e - Red-Purple Wire - Connect to Remaining Large Terminal on Slave Solenoid
f - Black-Yellow Wire - Connect to One Small Terminal on Slave Solenoid
g - Yellow-Red Wire - Connect to Other Small Terminal on Slave Solenoid
h - Receptacle
i - Black Wire - Connect to Flywheel Housing Attaching Stud on Starboard Side of Engine (Some Engines May Have a Screw);
j - Torque Nut or Screw to 20 Ft. Lbs. (27 N.m)
k - Black-Yellow Wire - Connect to One of the Terminals on Neutral Safety Switch
l - Yellow-Red Wire - Connect to "S" Terminal on Starter Mounted Solenoid
m - Red Wire - Connect to Large Terminal on Starter Mounted Solenoid
n - Purple-Yellow Wire - Connect to "R" Terminal on Starter Mounted Solenoid
o - Brown-White Wire - Taped to Harness and Insulated
p - Light Blue Wire - Connect to Oil Pressure Sender on Aft End of Engine near Circuit Breaker on MIE 228/255 or Port Side of Engine on MIE 330 (on MIE 330, the Sta-Strap, That Secures Wire to Harness, Must Be Removed to Extend Wire)
q - Sta-Strap
r - Gray Wire - Connect to Negative (-) Terminal on Ignition Coil
s - Purple-Yellow and Purple Wire - Connect to Positive (+) Terminal on Ignition Coil
t - Tan Wire - Connect to Water Temperature Sender on Starboard Side of Intake Manifold Near Thermostat Housing
*u - Red-Purple Wire - Connect to Alternator Red-Purple (or Red) Wire
*v - Purple Wire - Connect to Alternator Purple (or White) Wire
w - Orange Wire - Connect to Alternator Output ("BAT") Terminal
x - Black Wire - Connect to Alternator Ground Terminal

**Install and shrink sleeves (supplied with harness) over these quick disconnect terminals. Be sure that all exposed metal on the terminals is covered.*

Figure 6. Wiring Harness (84-86677A2) Electrical Connections

SECTION 3 - ELECTRICAL SYSTEM

PART F - WIRING DIAGRAMS



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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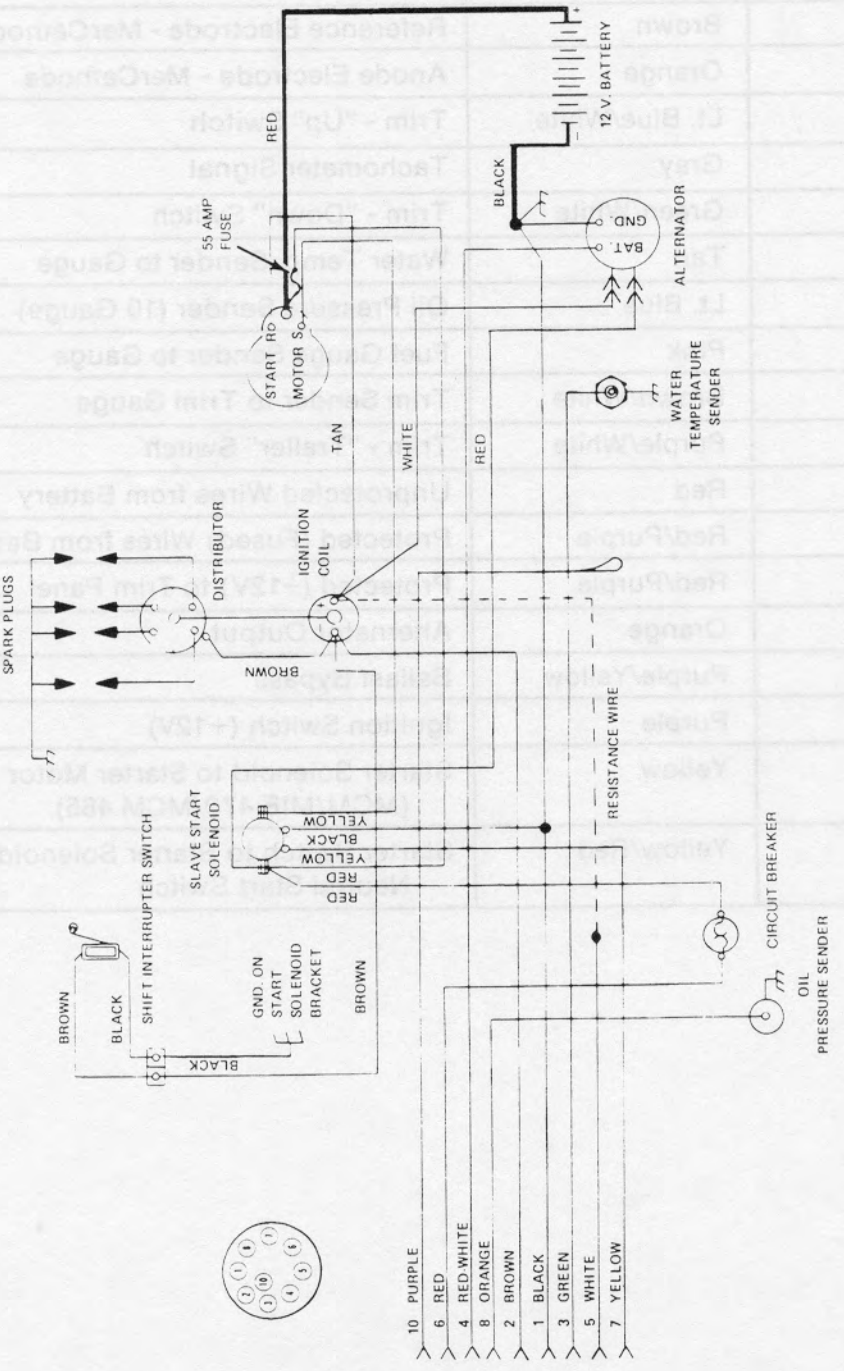
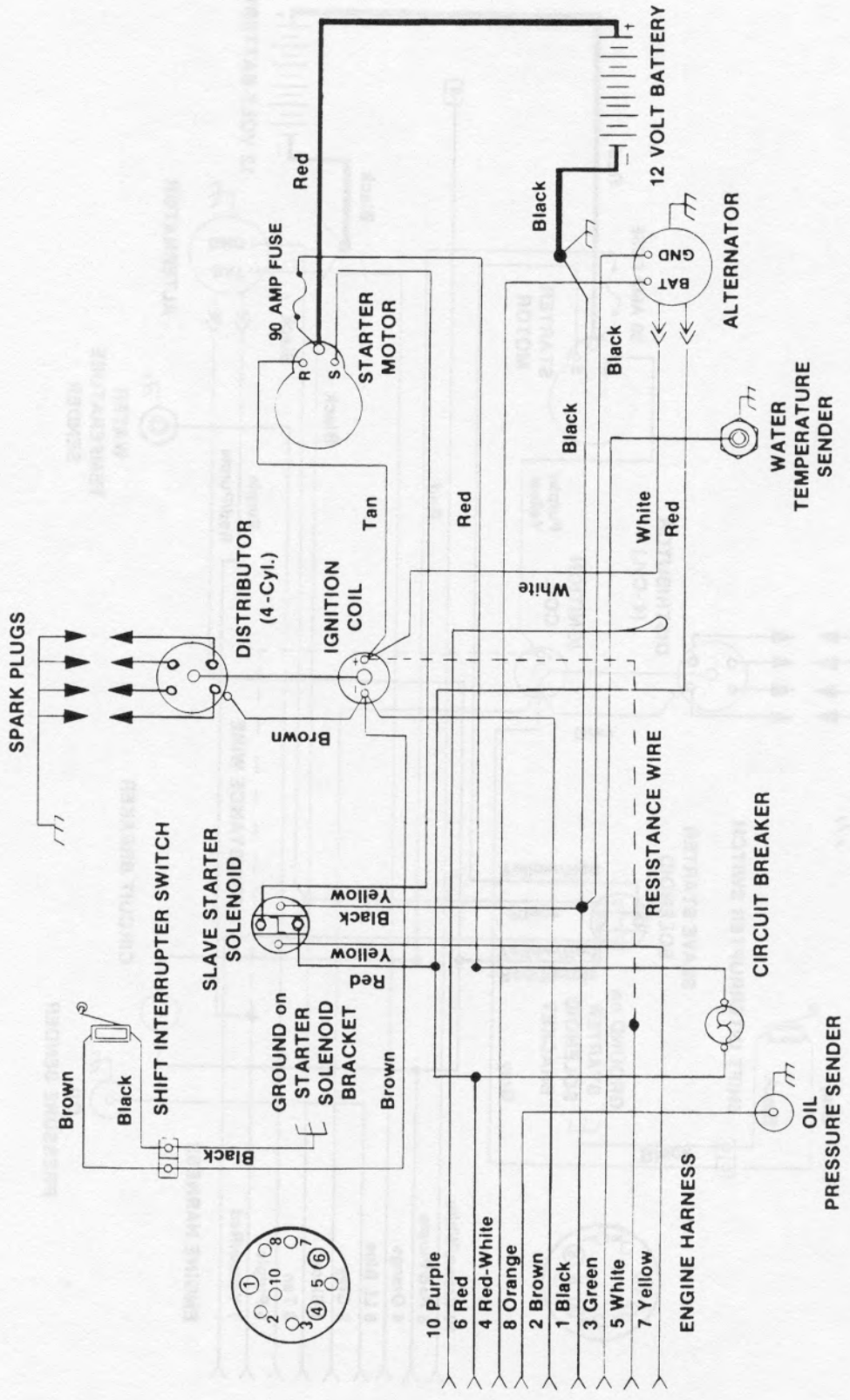
WIRING COLORS for MERCRUISER (Cross-Reference Chart)

(In Alphabetical Order of Pre BIA Colors)

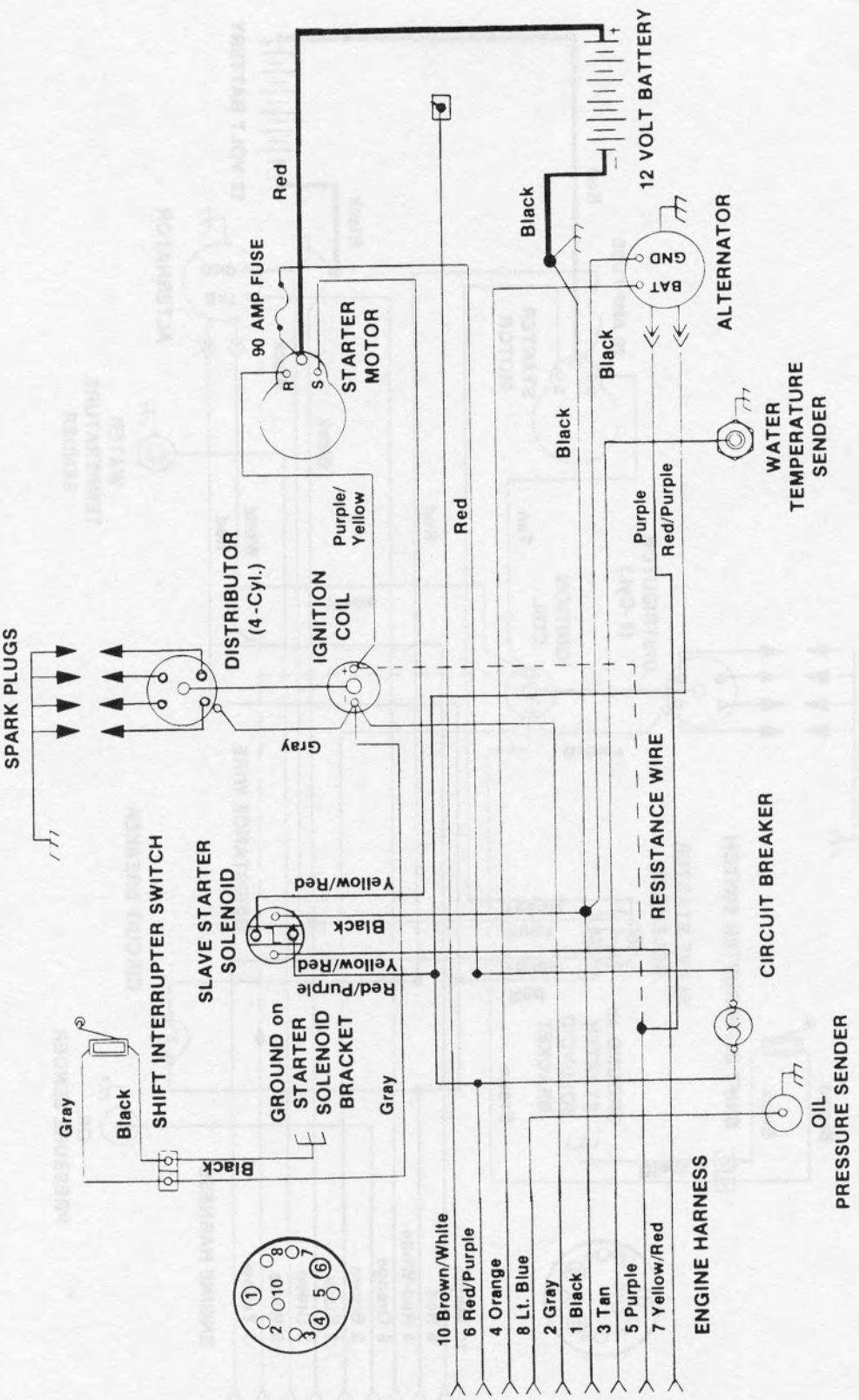
Pre BIA Color Code	BIA Color Code	Where Used
Black	Black	All Grounds
Black	Brown	Reference Electrode - MerCathode
Black	Orange	Anode Electrode - MerCathode
Blue	Lt. Blue/White	Trim - "Up" Switch
Brown	Gray	Tachometer Signal
Green	Green/White	Trim - "Down" Switch
Green	Tan	Water Temp. Sender to Gauge
Orange	Lt. Blue	Oil Pressure Sender (10 Gauge)
Pink	Pink	Fuel Gauge Sender to Gauge
Purple	Brown/White	Trim Sender to Trim Gauge
Purple	Purple/White	Trim - "Trailer" Switch
Red	Red	Unprotected Wires from Battery
Red	Red/Purple	Protected (Fused) Wires from Battery
Red	Red/Purple	Protected (+12V) to Trim Panel
Red/White	Orange	Alternator Output
Tan	Purple/Yellow	Ballast Bypass
White	Purple	Ignition Switch (+12V)
Yellow	Yellow	Starter Solenoid to Starter Motor (MCM/MIE 470/MCM 485)
Yellow	Yellow/Red	Starter Switch to Starter Solenoid to Neutral Start Switch



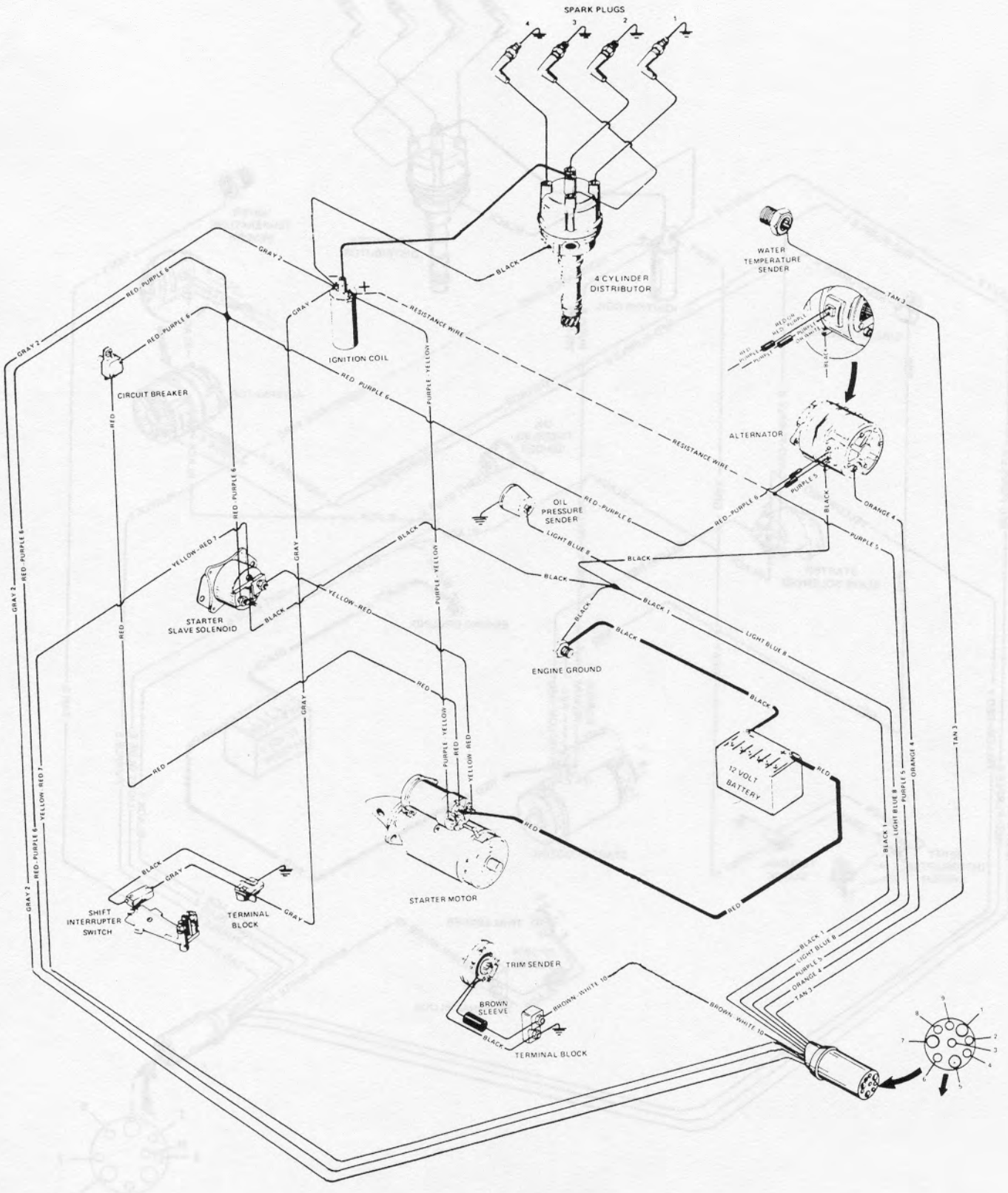
MCM 120/140 Engine Wiring Diagram
Pre BIA Color Code with 55 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



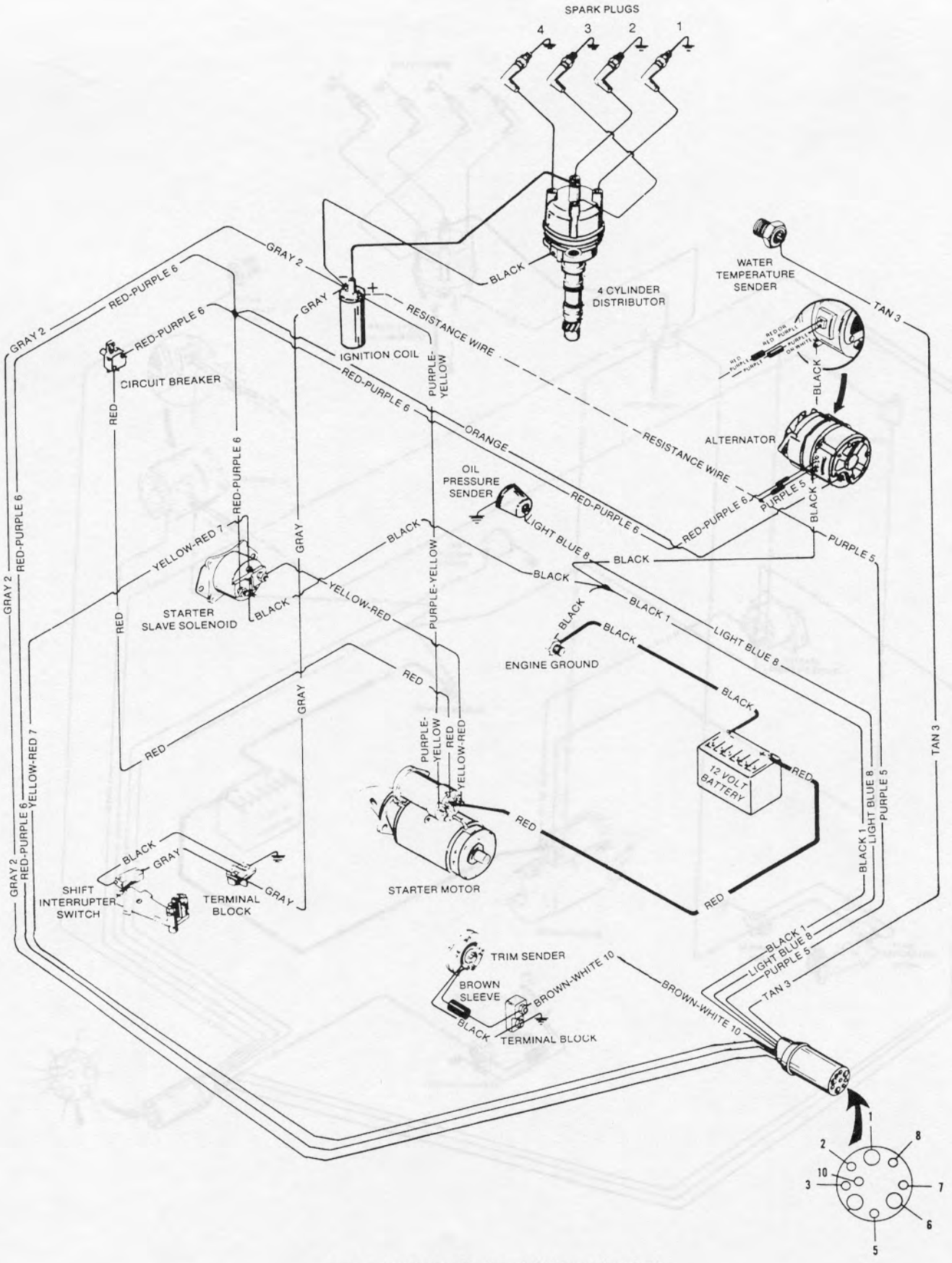
MCM 120/140 Engine Wiring Diagram
Pre BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



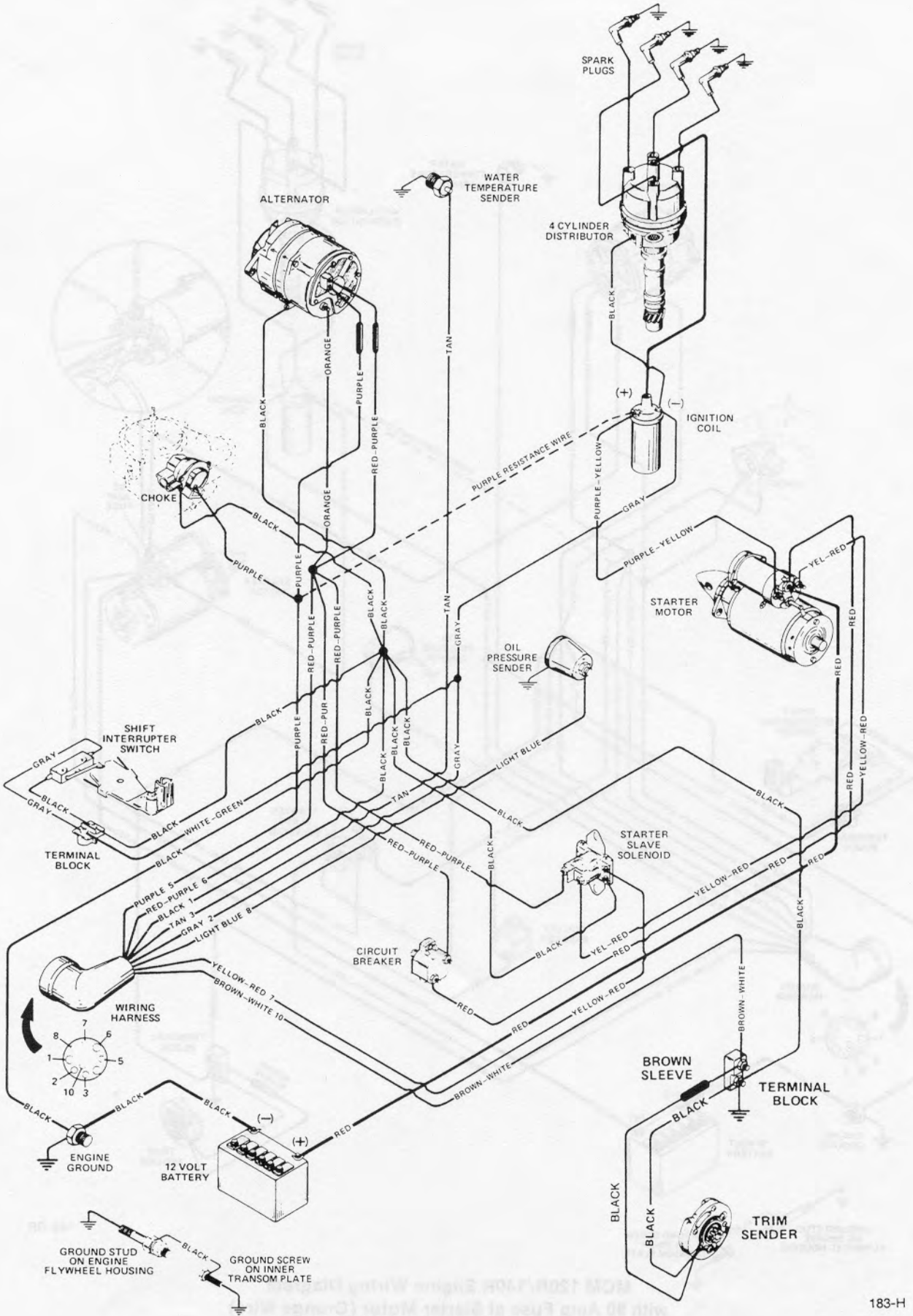
MCM 120/140 Engine Wiring Diagram
BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



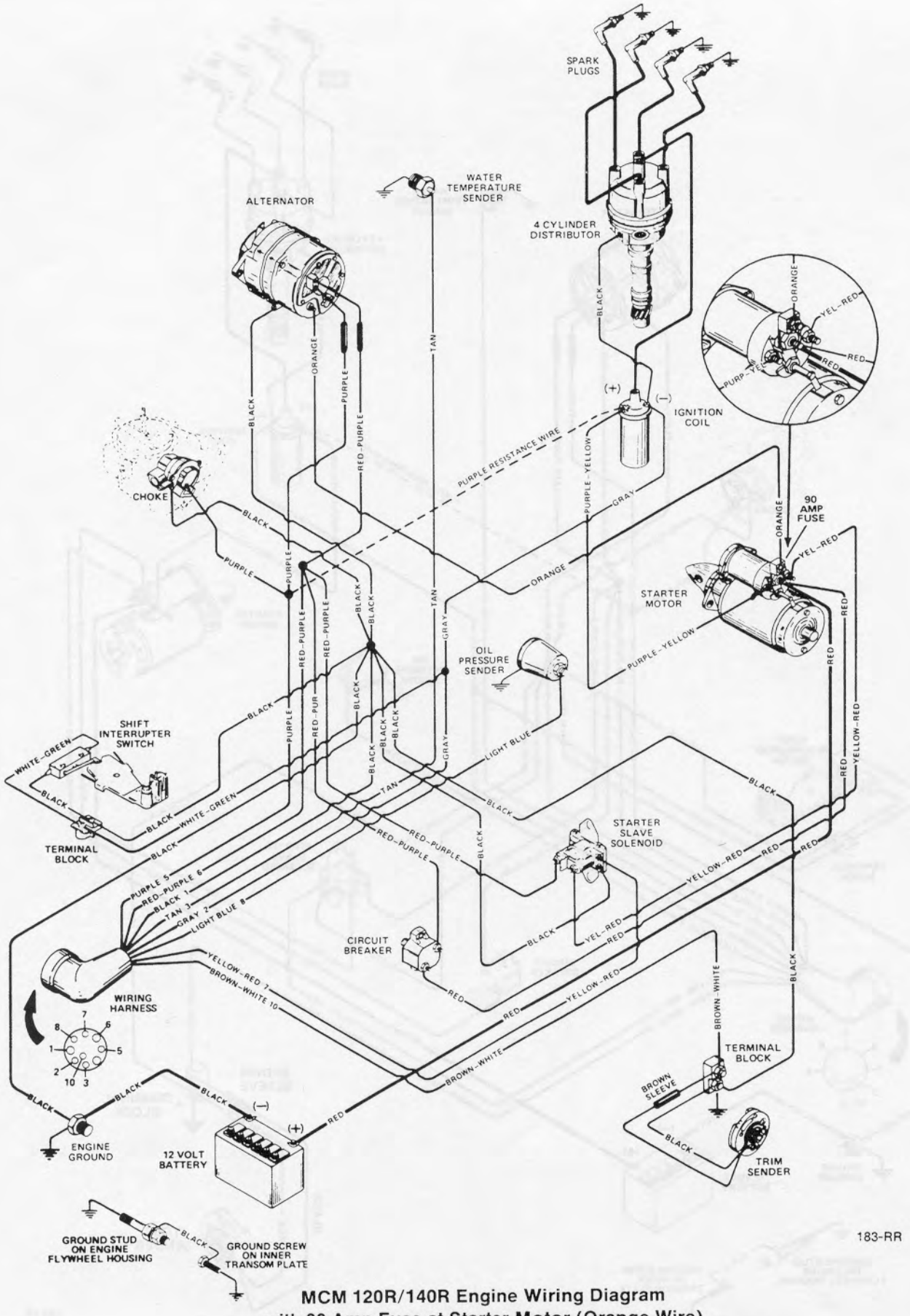
MCM 120/140 Engine Wiring Diagram
BIA Color Code without 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



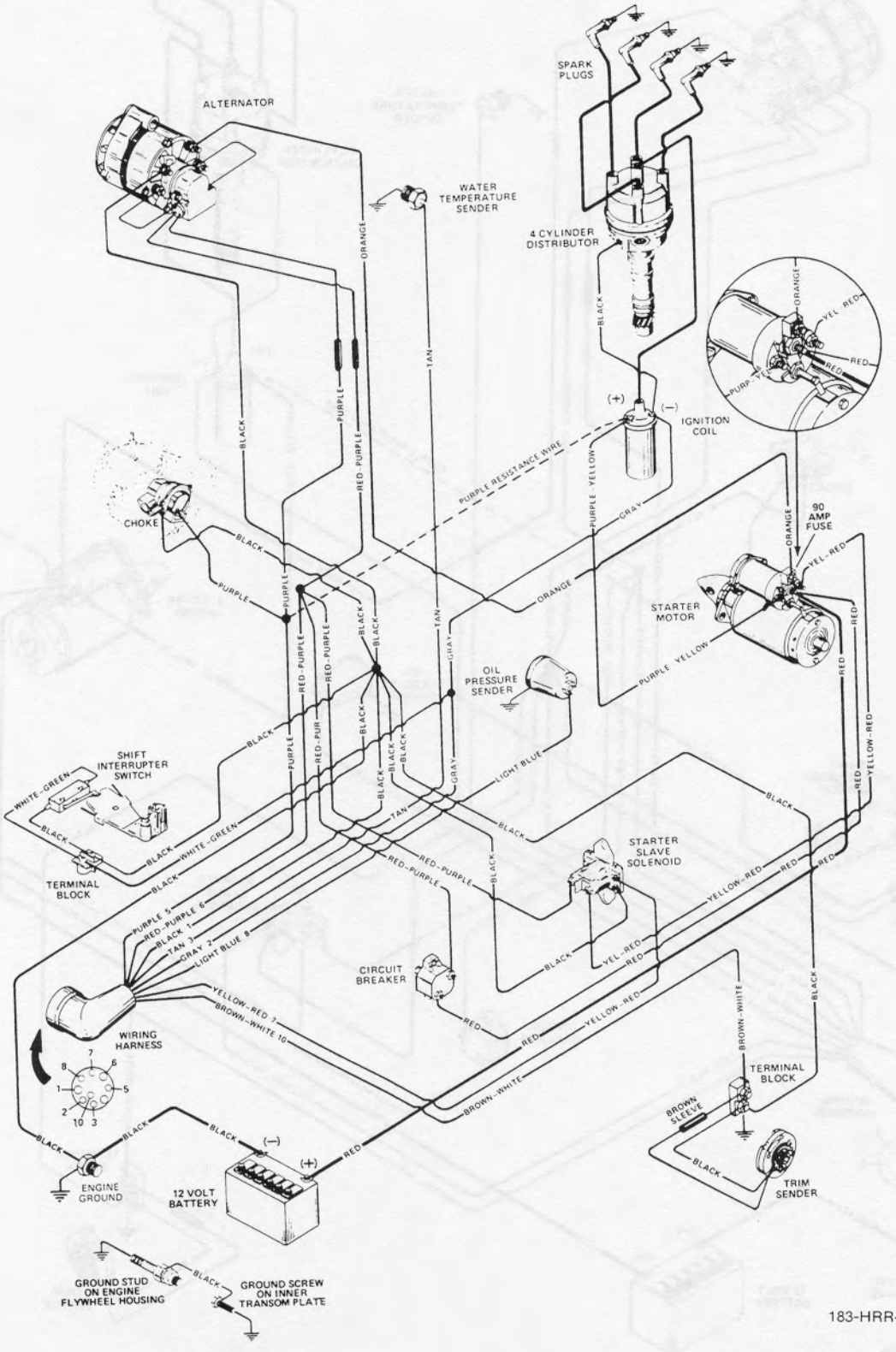
MCM 120/140 Engine Wiring Diagram
(Battery Meter Circuit)



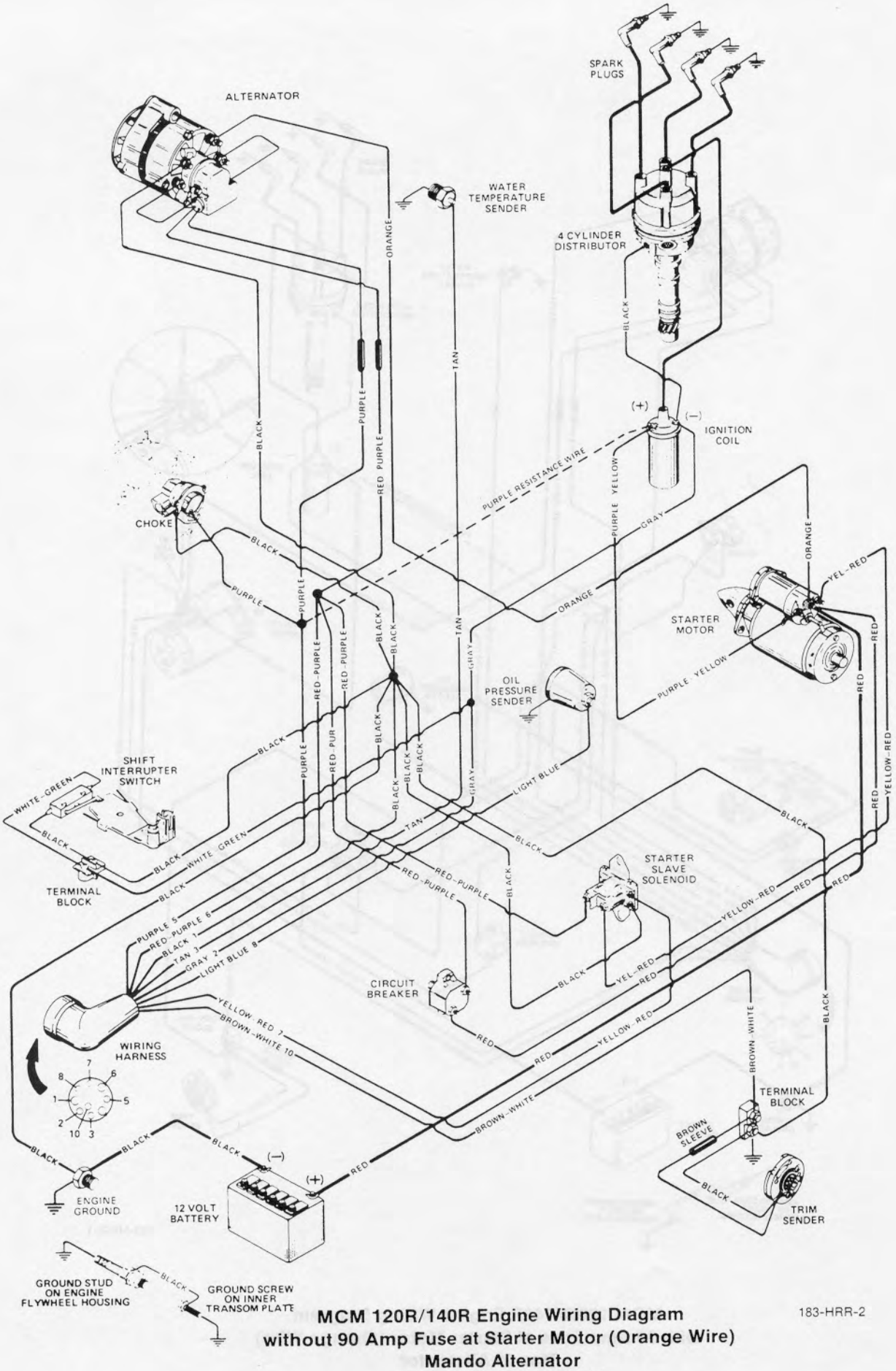
MCM 120R/140R Engine Wiring Diagram
(Battery Meter Circuit)



MCM 120R/140R Engine Wiring Diagram
with 90 Amp Fuse at Starter Motor (Orange Wire)
Delco Alternator
(Battery Meter Circuit)

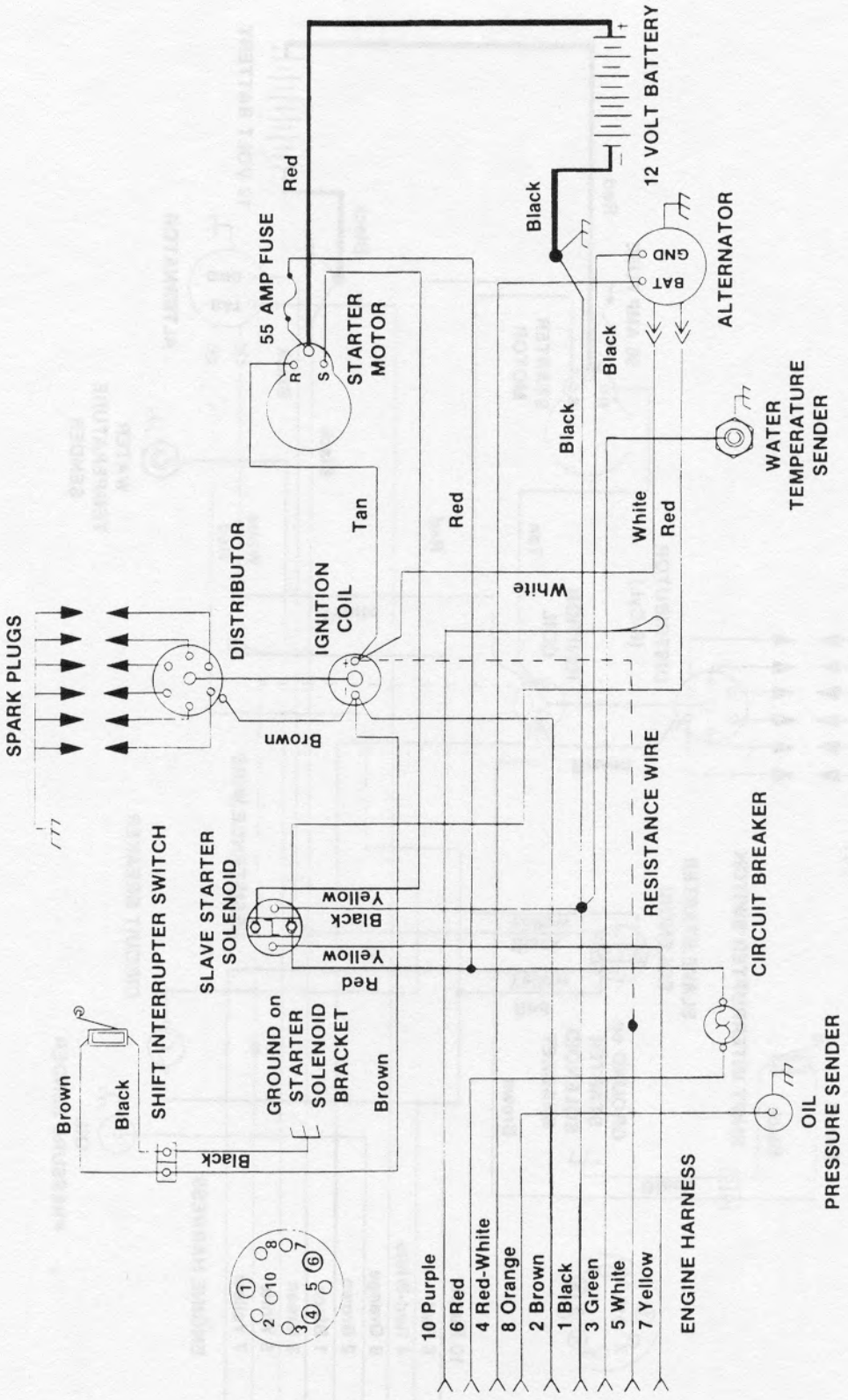


MCM 120R/140R Engine Wiring Diagram
with 90 Amp Fuse at Starter Motor (Orange Wire)
Mando Alternator
(Battery Meter Circuit)

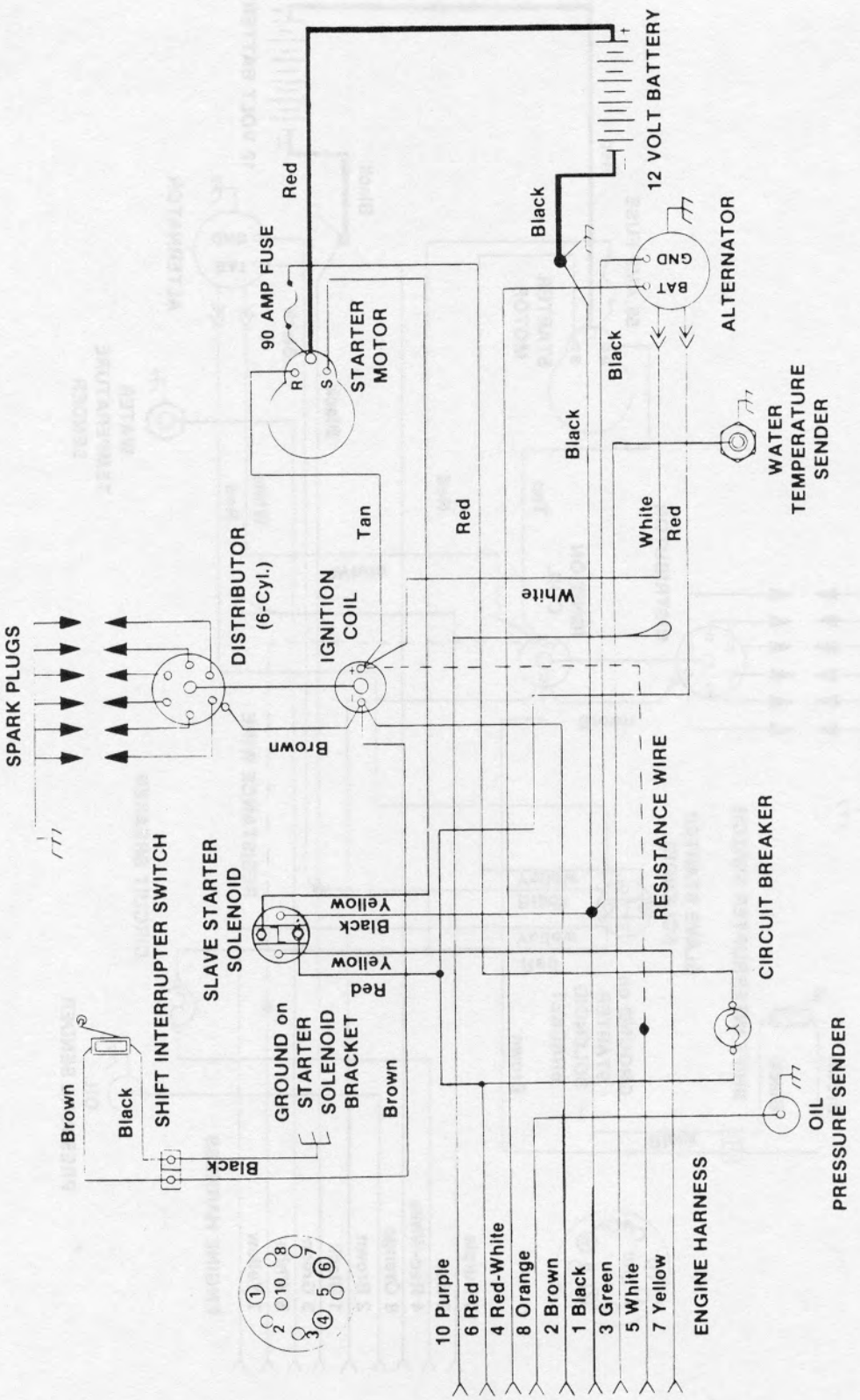


MCM 120R/140R Engine Wiring Diagram
without 90 Amp Fuse at Starter Motor (Orange Wire)
Mando Alternator
(Battery Meter Circuit)

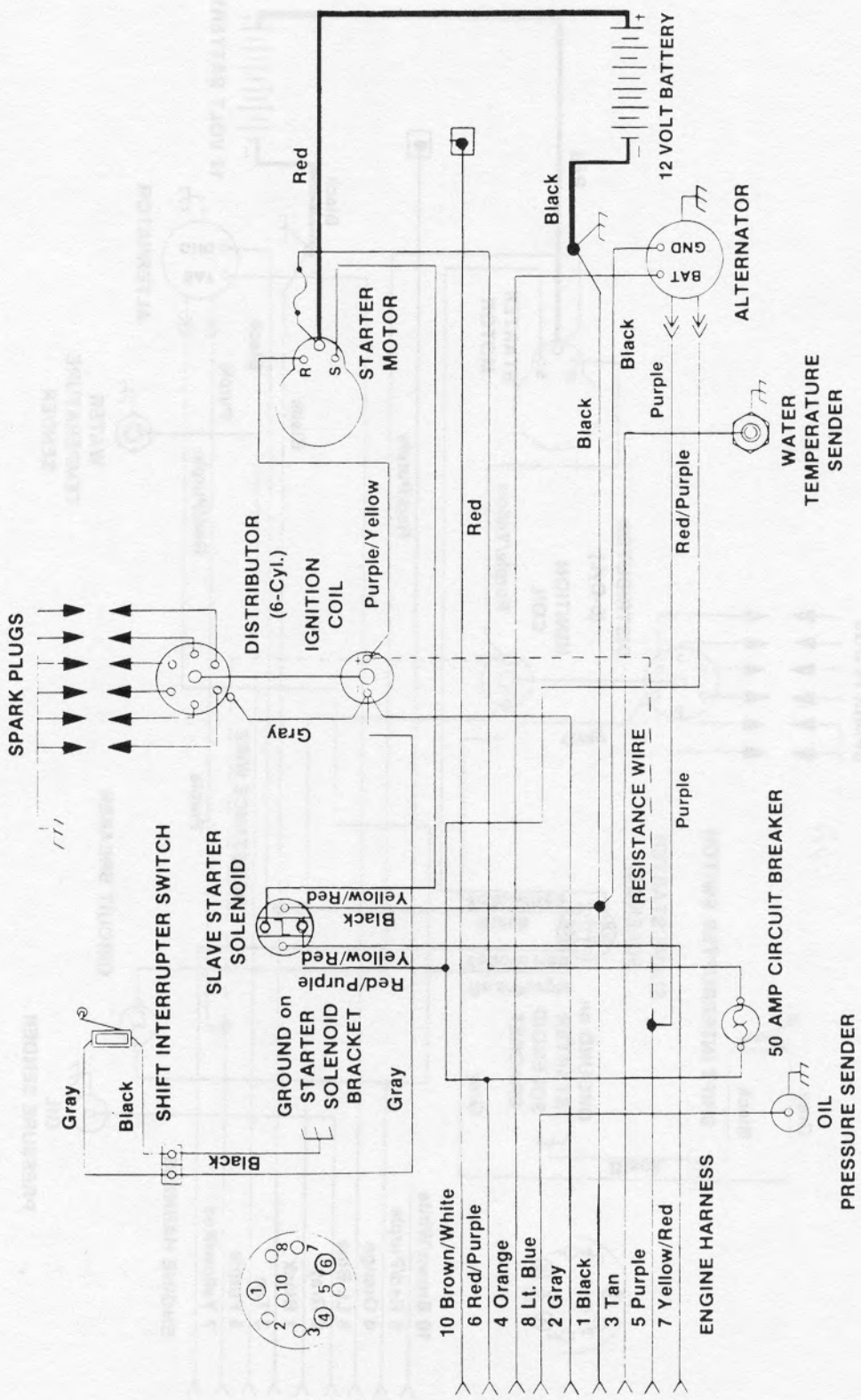
183-HRR-2



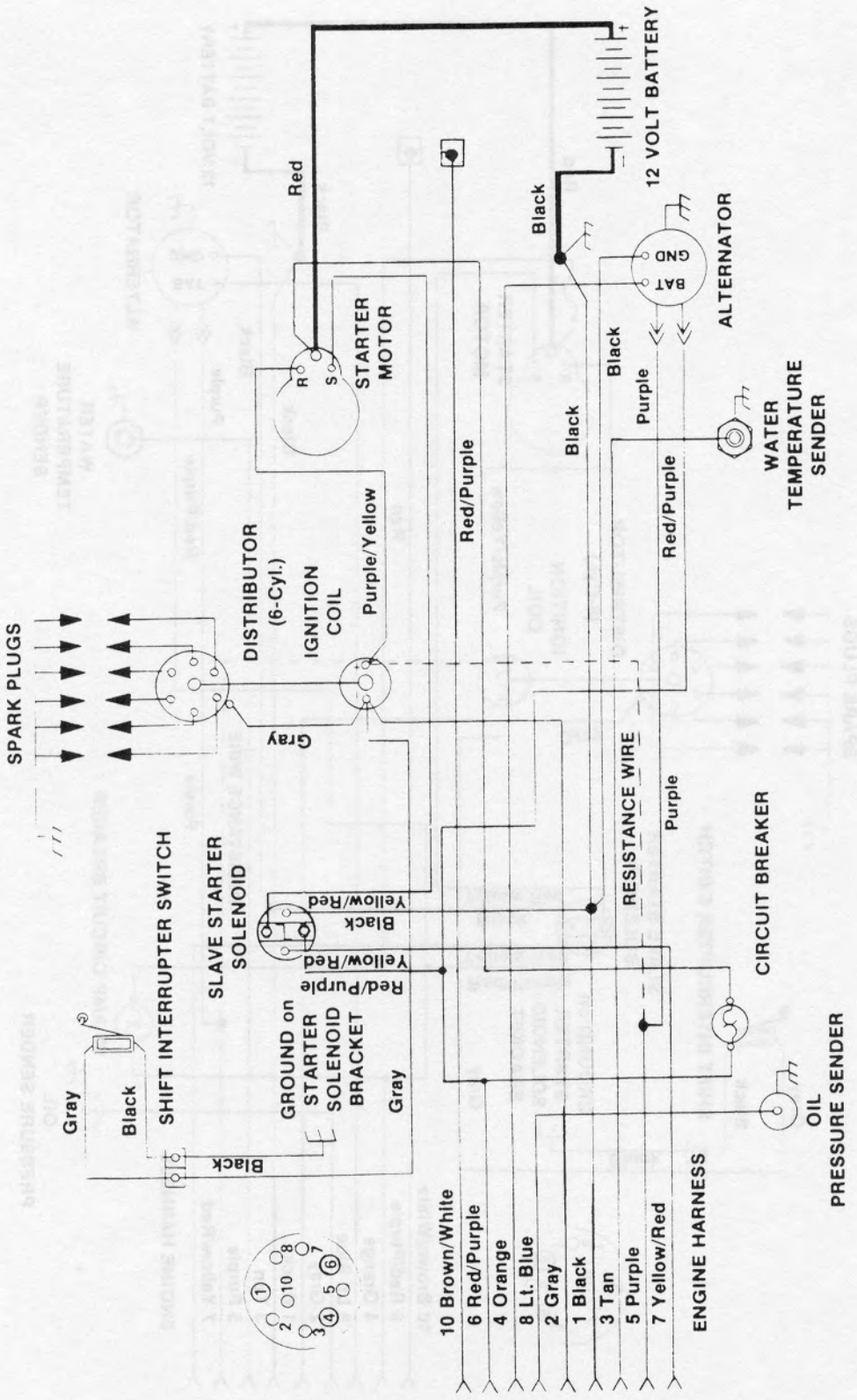
MCM 165 Engine Wiring Diagram
Pre BIA Color Code with 55 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



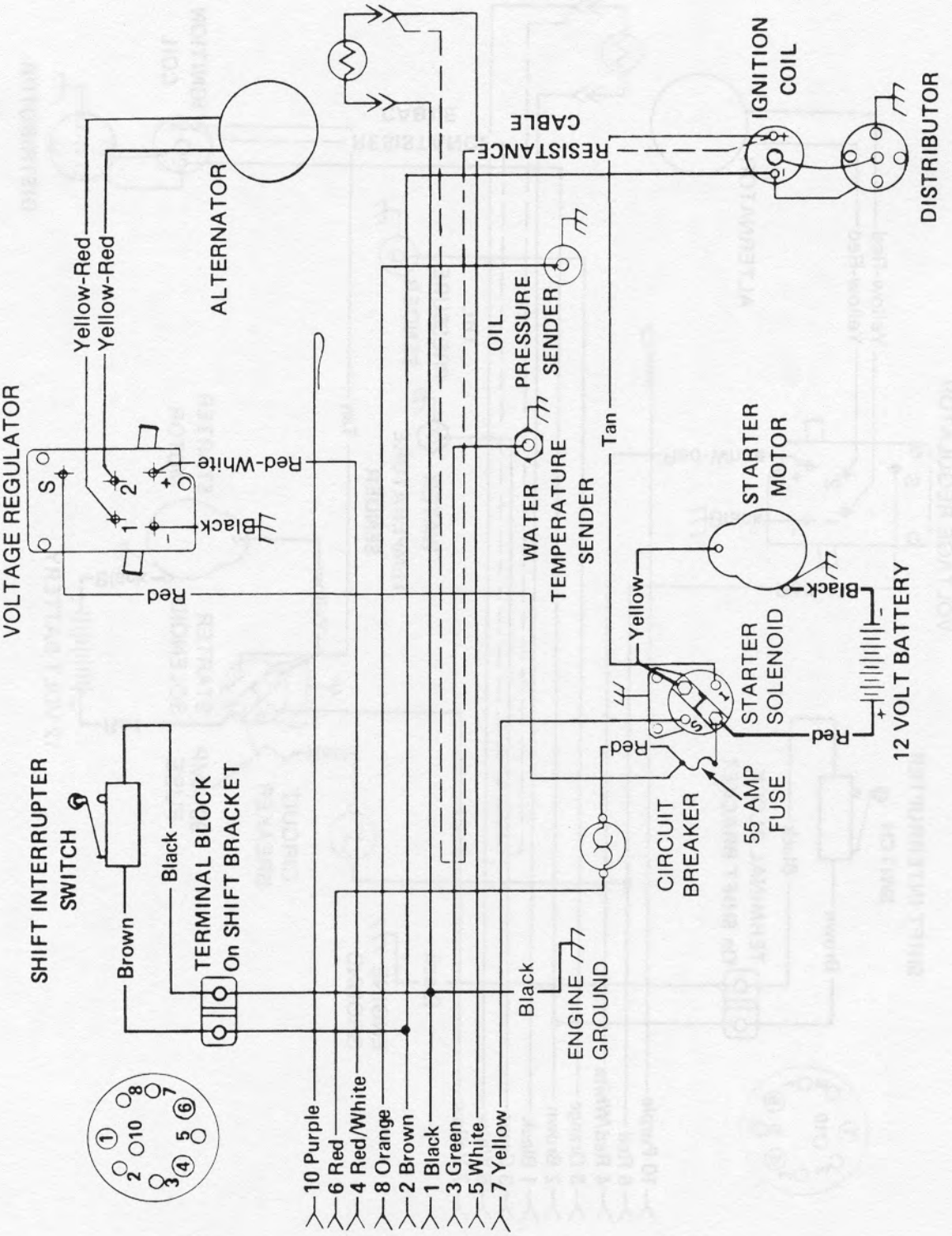
MCM 165 Engine Wiring Diagram
Pre BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



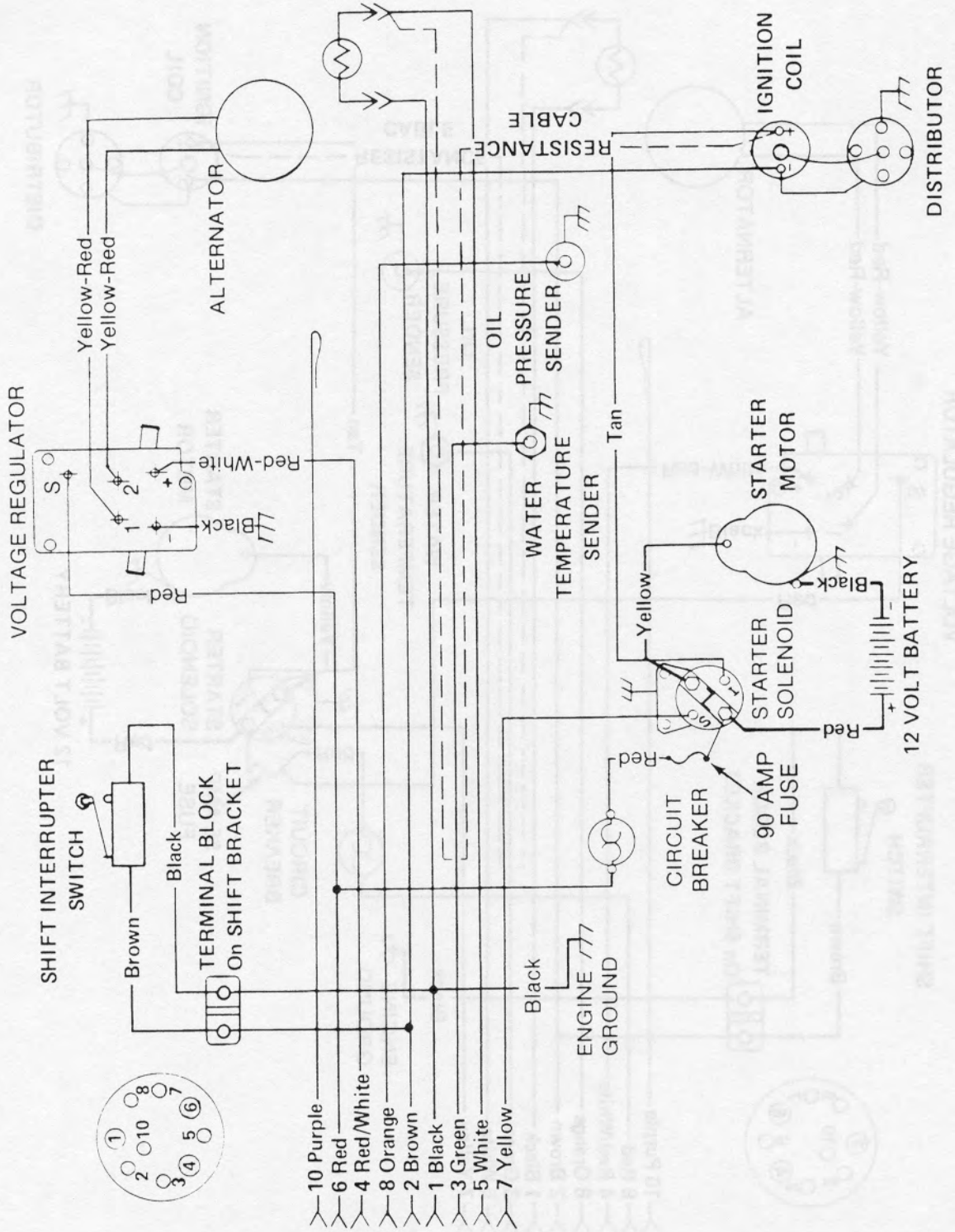
MCM 165 Engine Wiring Diagram
BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



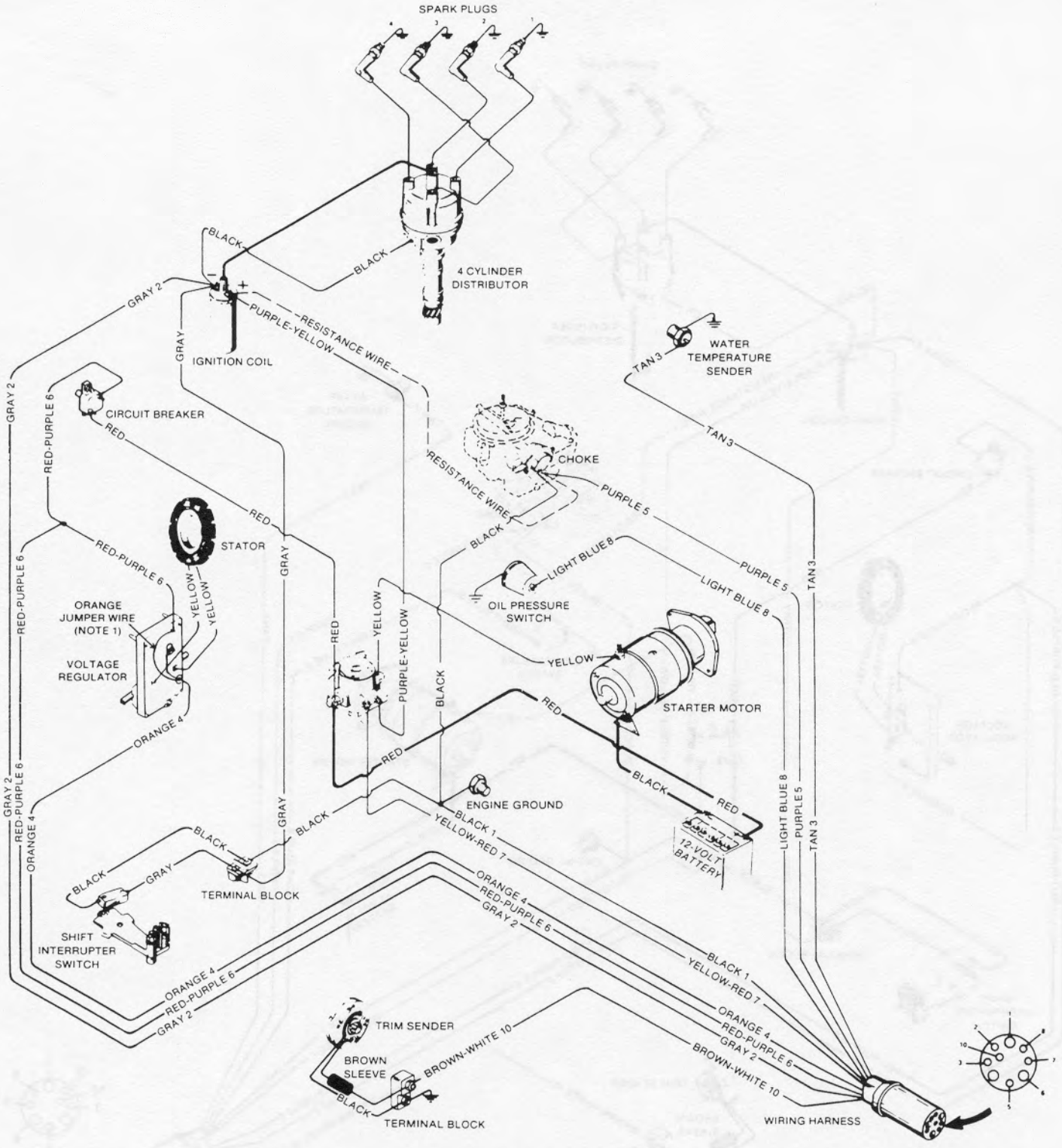
MCM 165 Engine Wiring Diagram
BIA Color Code without 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



MCM 470 Engine Wiring Diagram
Pre BIA Color Code with 55 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)

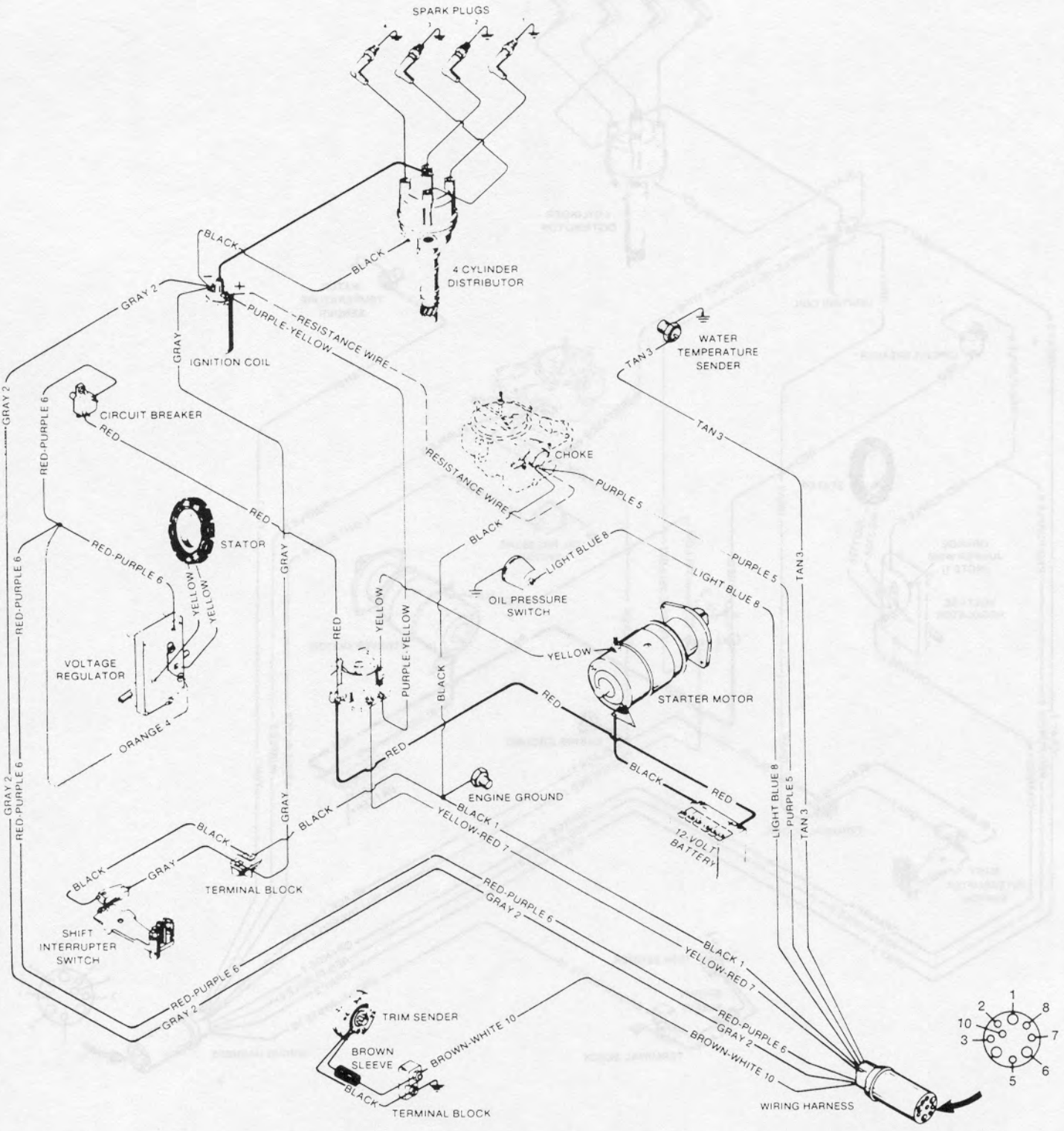


MCM 470 Engine Wiring Diagram
Pre BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)

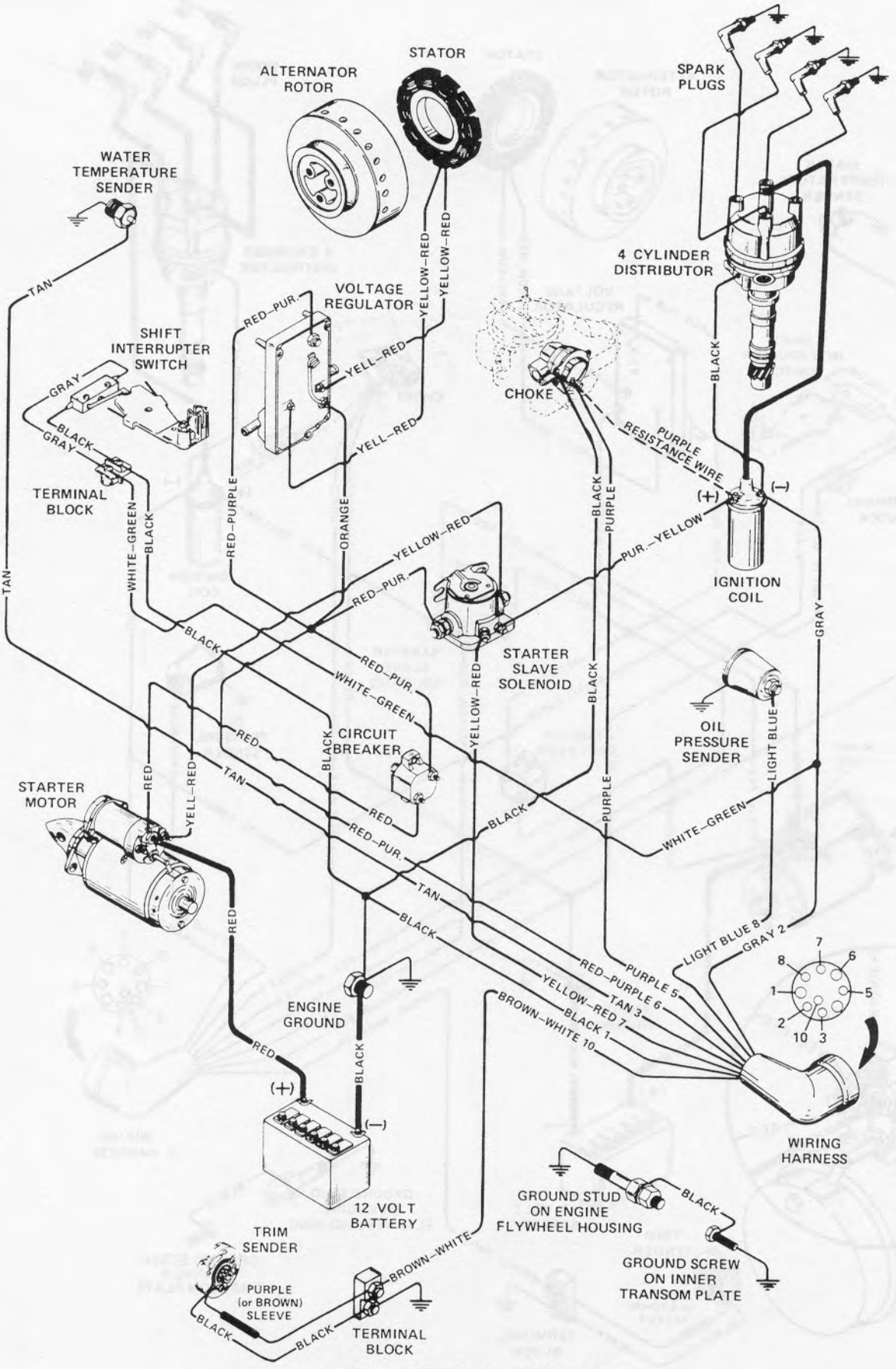


NOTE 1: Remove this wire if ammeter is to be used. Jumper must be left connected if Battery Meter is used.

MCM 470 Engine Wiring Diagram
BIA Color Code
(Ammeter Circuit)

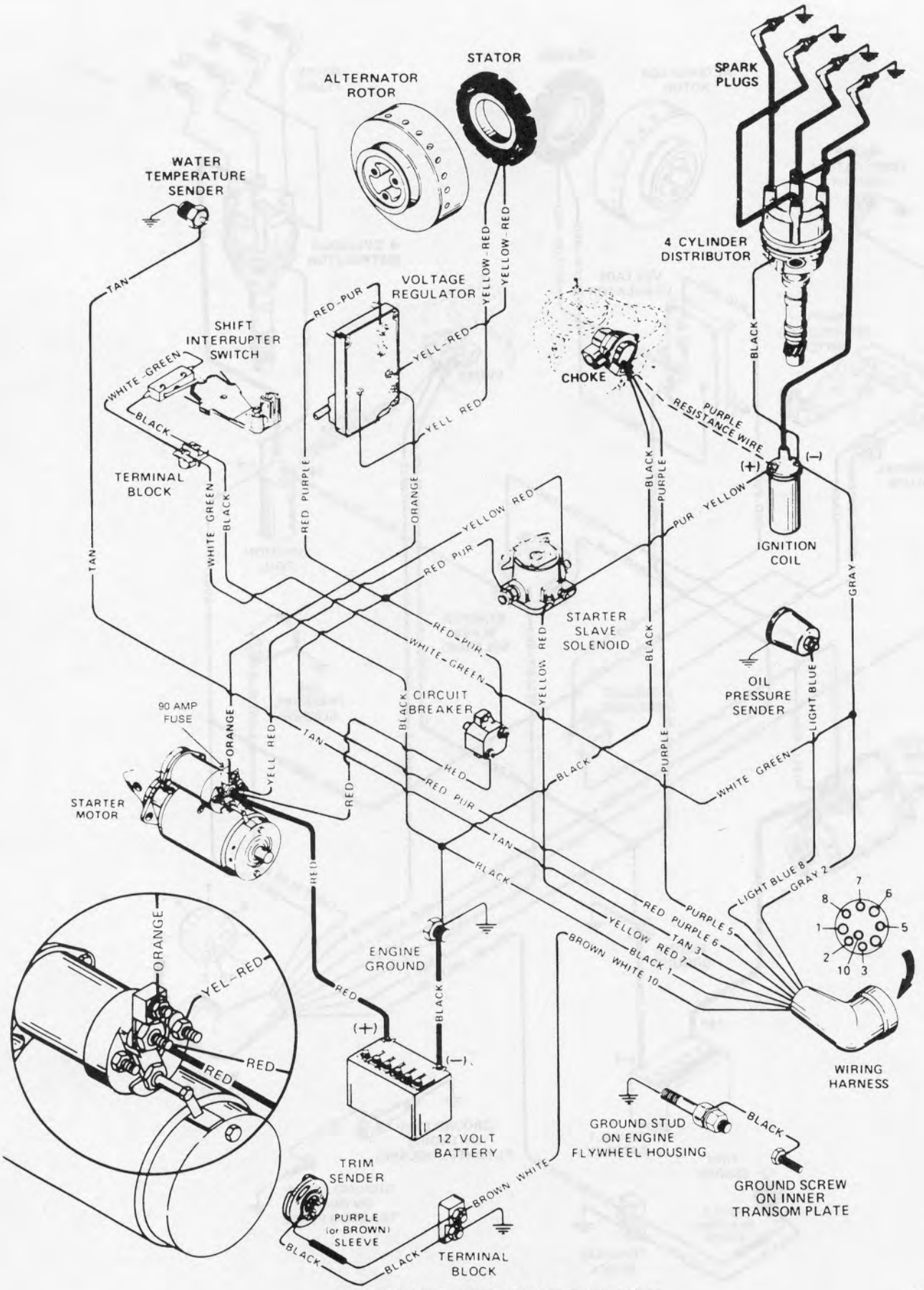


MCM 470 Engine Wiring Diagram
BIA Color Code
(Battery Meter Circuit)



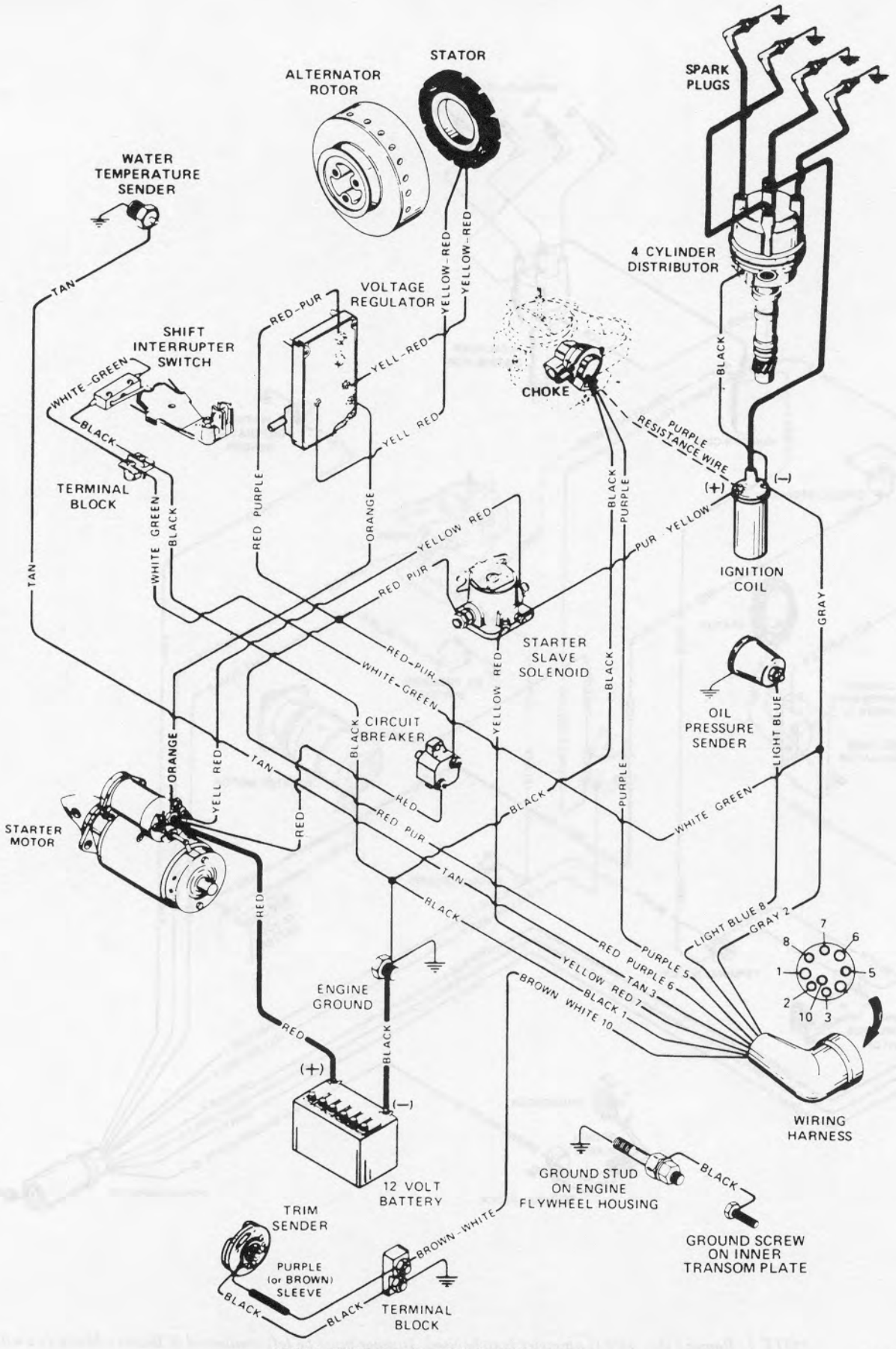
MCM 470R Engine Wiring Diagram
Delco Starter Motor
(Battery Meter Circuit)

192-H



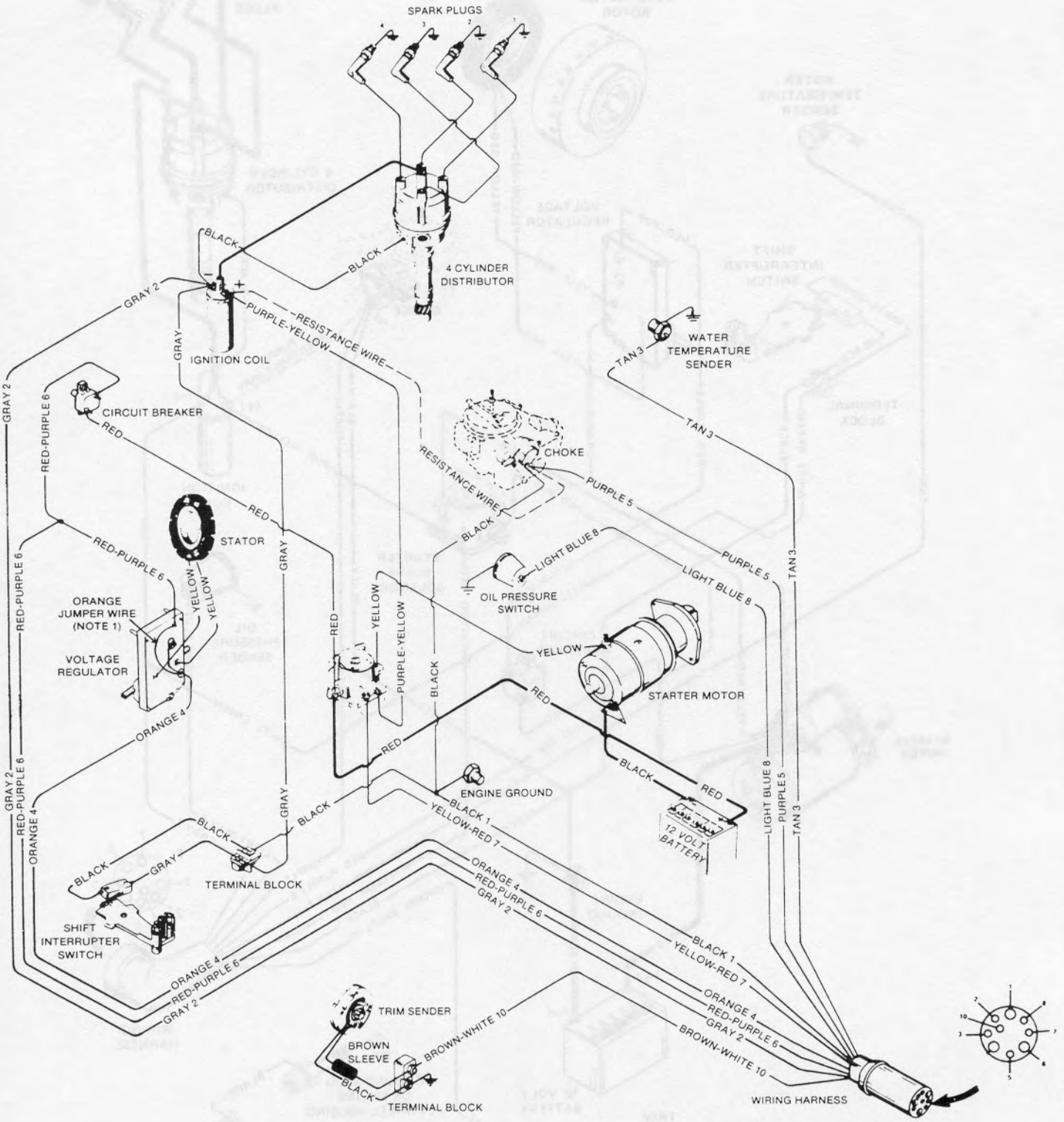
MCM 470R Engine Wiring Diagram
with 90 Amp Fuse at Delco Starter Motor (Orange Wire)
(Battery Meter Circuit)

192-HRR



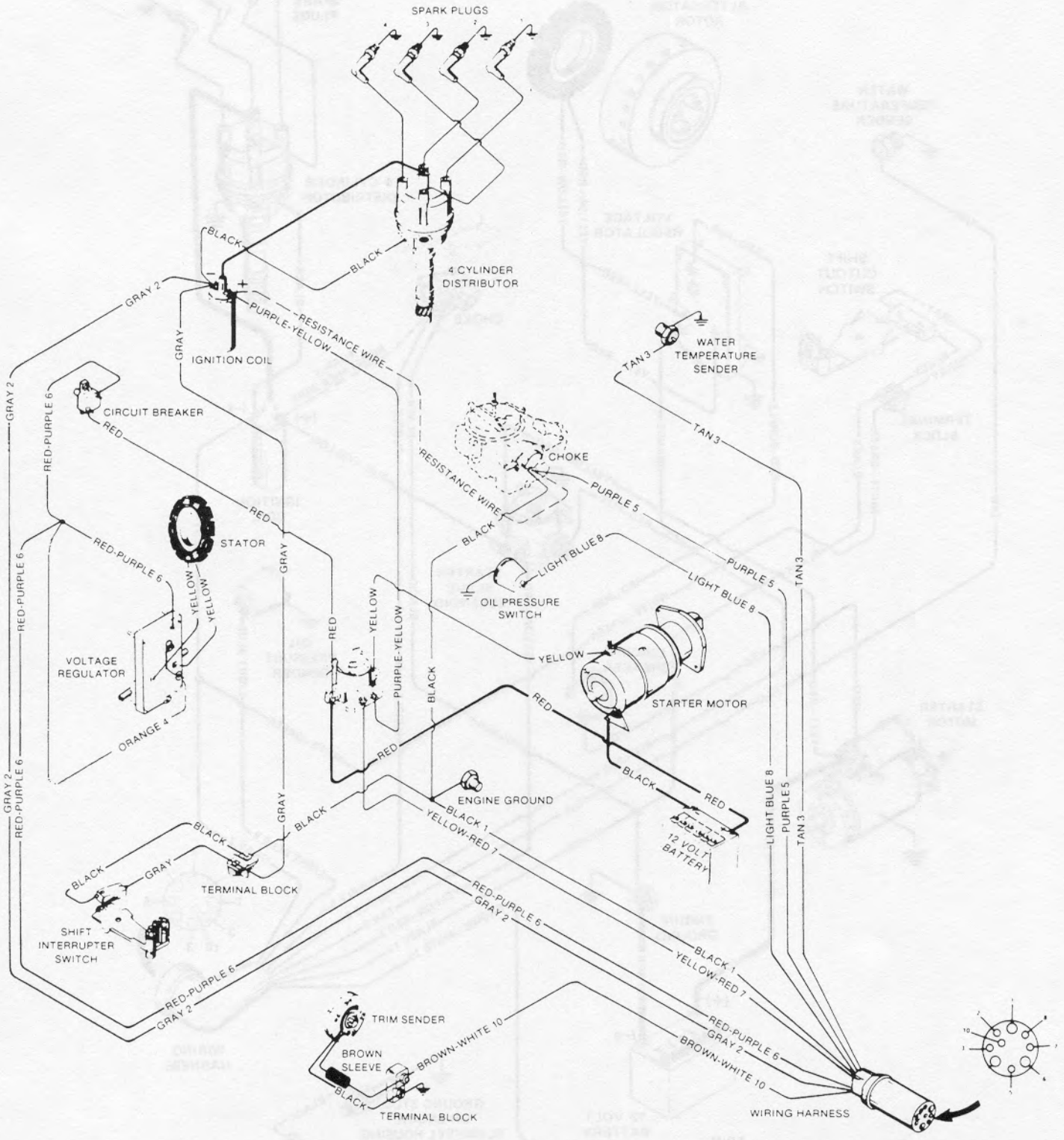
MCM 470R Engine Wiring Diagram
without 90 Amp Fuse at Delco Starter Motor (Orange Wire)
(Battery Meter Circuit)

192-HRR

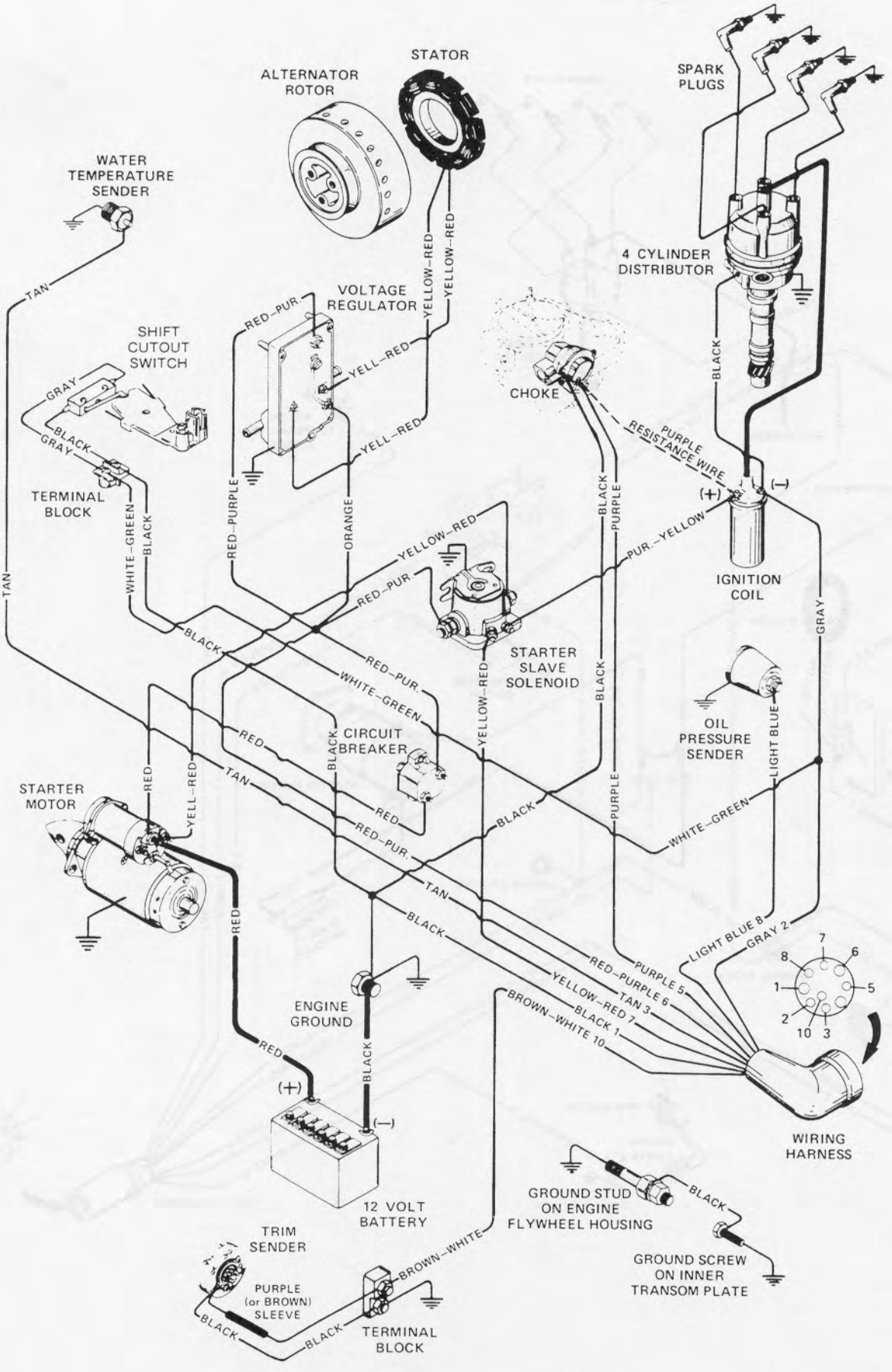


NOTE 1: Remove this wire if ammeter is to be used. Jumper must be left connected if Battery Meter is used.

MCM 485 Engine Wiring Diagram
(Ammeter Circuit)

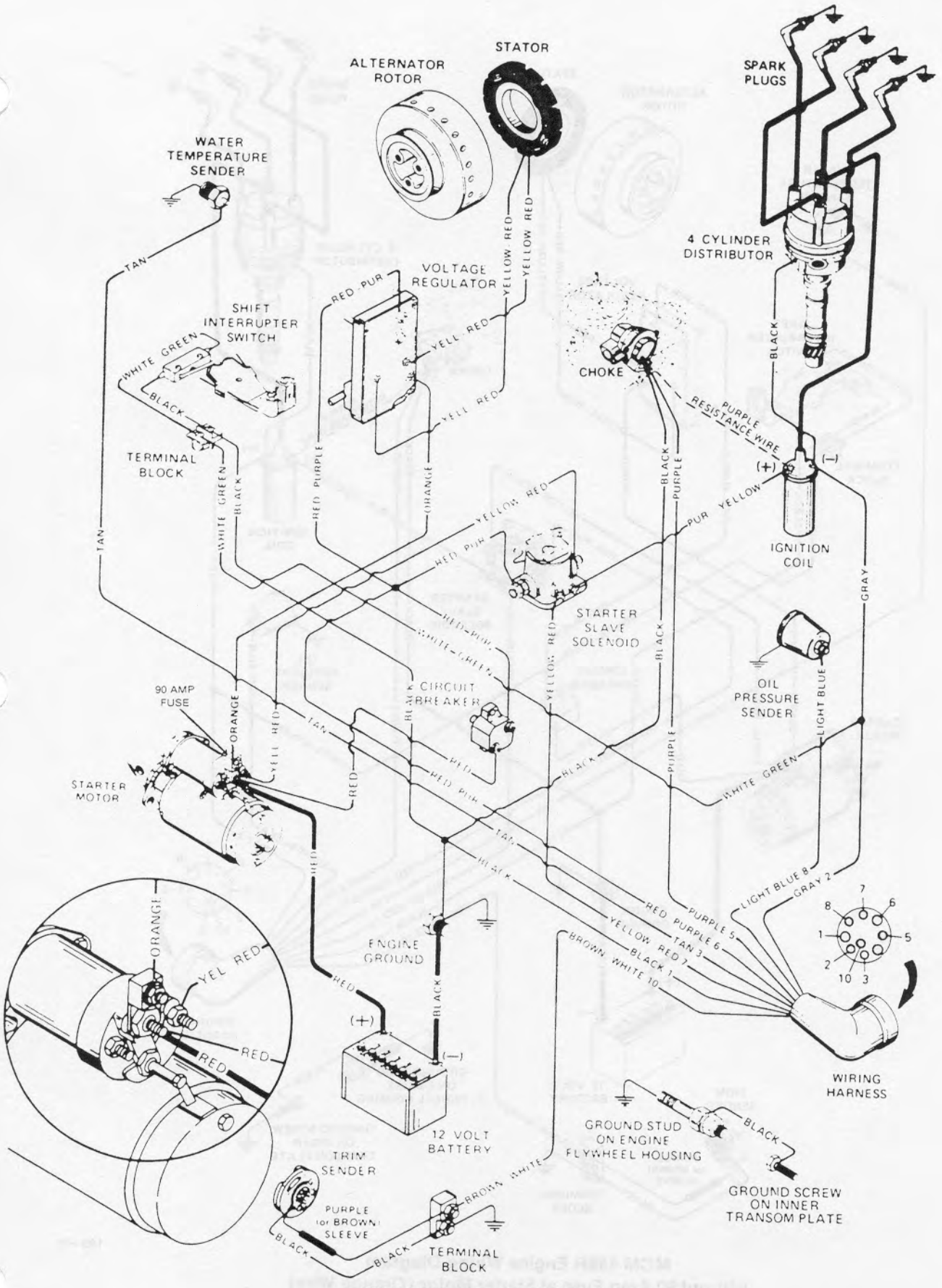


MCM 485 Engine Wiring Diagram
(Battery Meter Circuit)



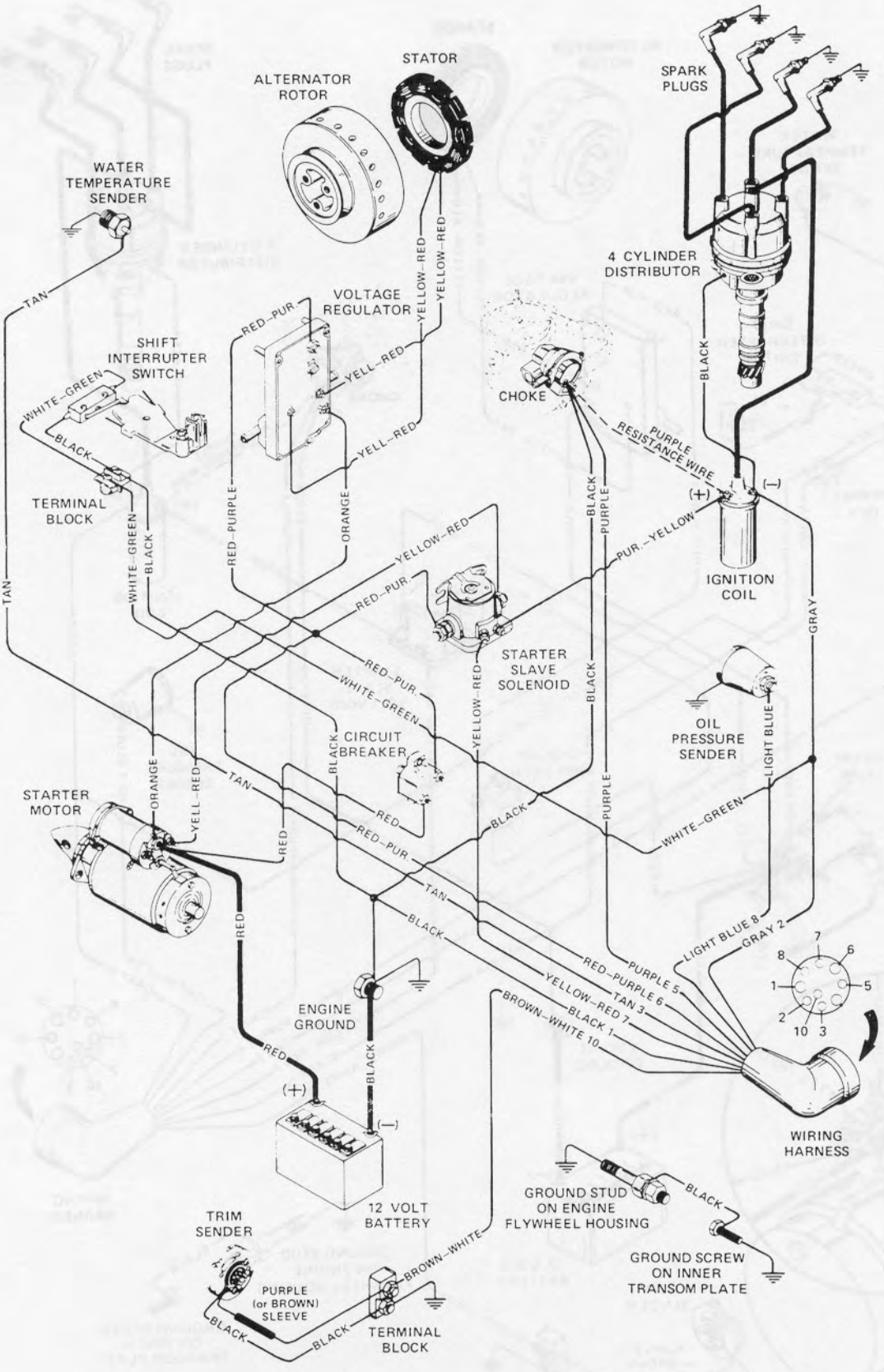
192-H

MCM 488R Engine Wiring Diagram
(Battery Meter Circuit)



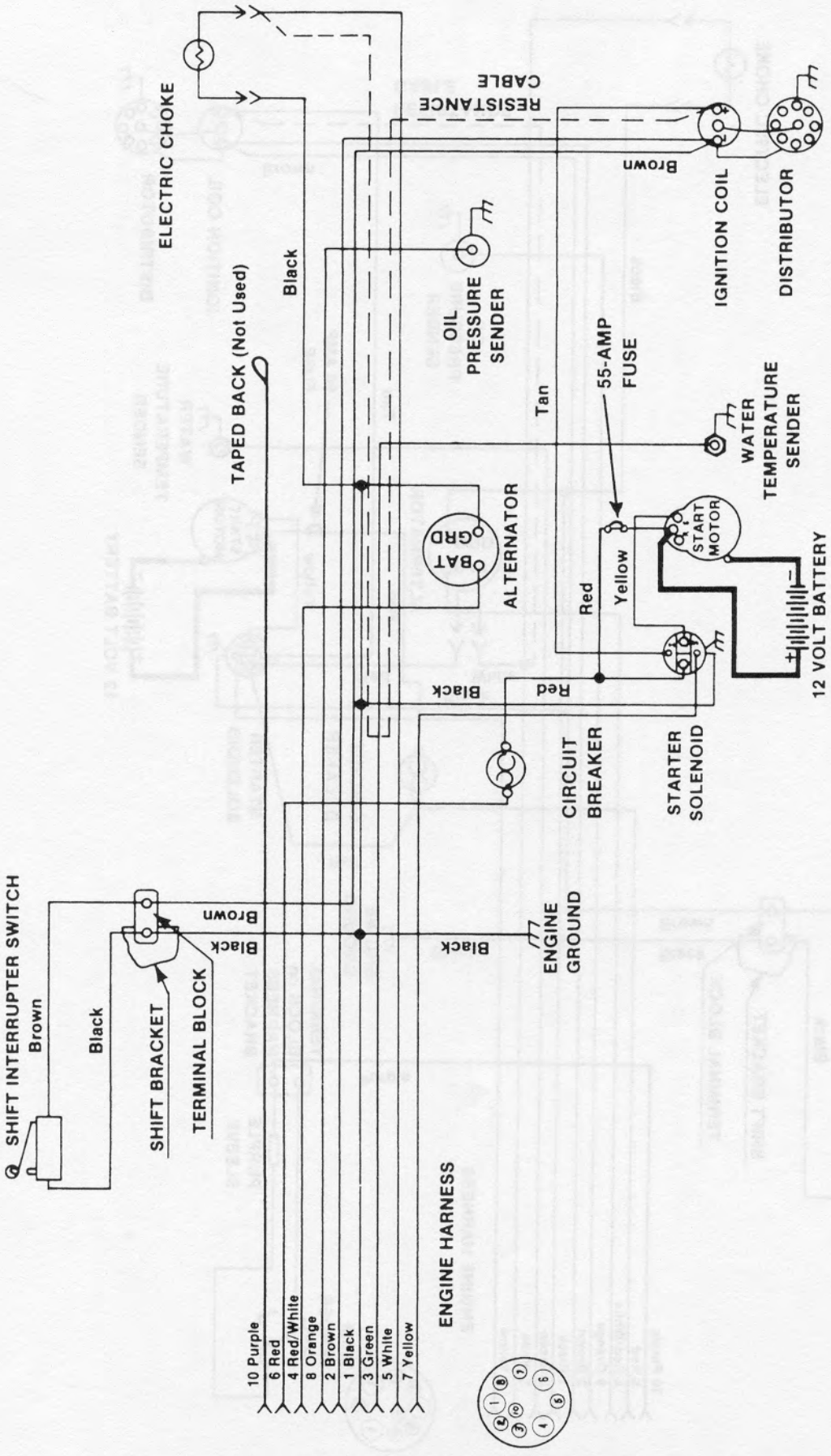
MCM 488R Engine Wiring Diagram
with 90 Amp Fuse at Starter Motor (Orange Wire)
(Battery Meter Circuit)

192-HR

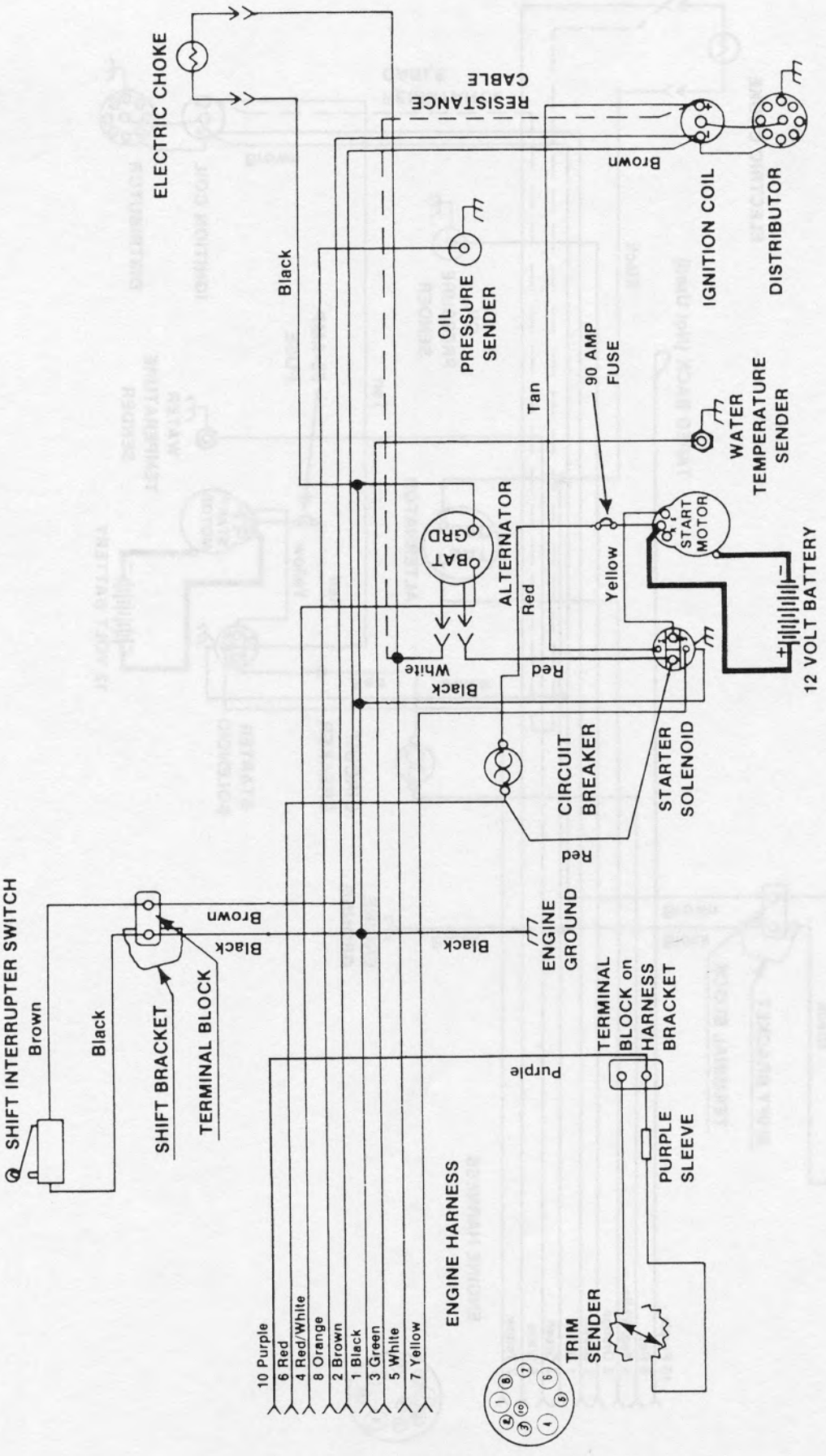


193-H3

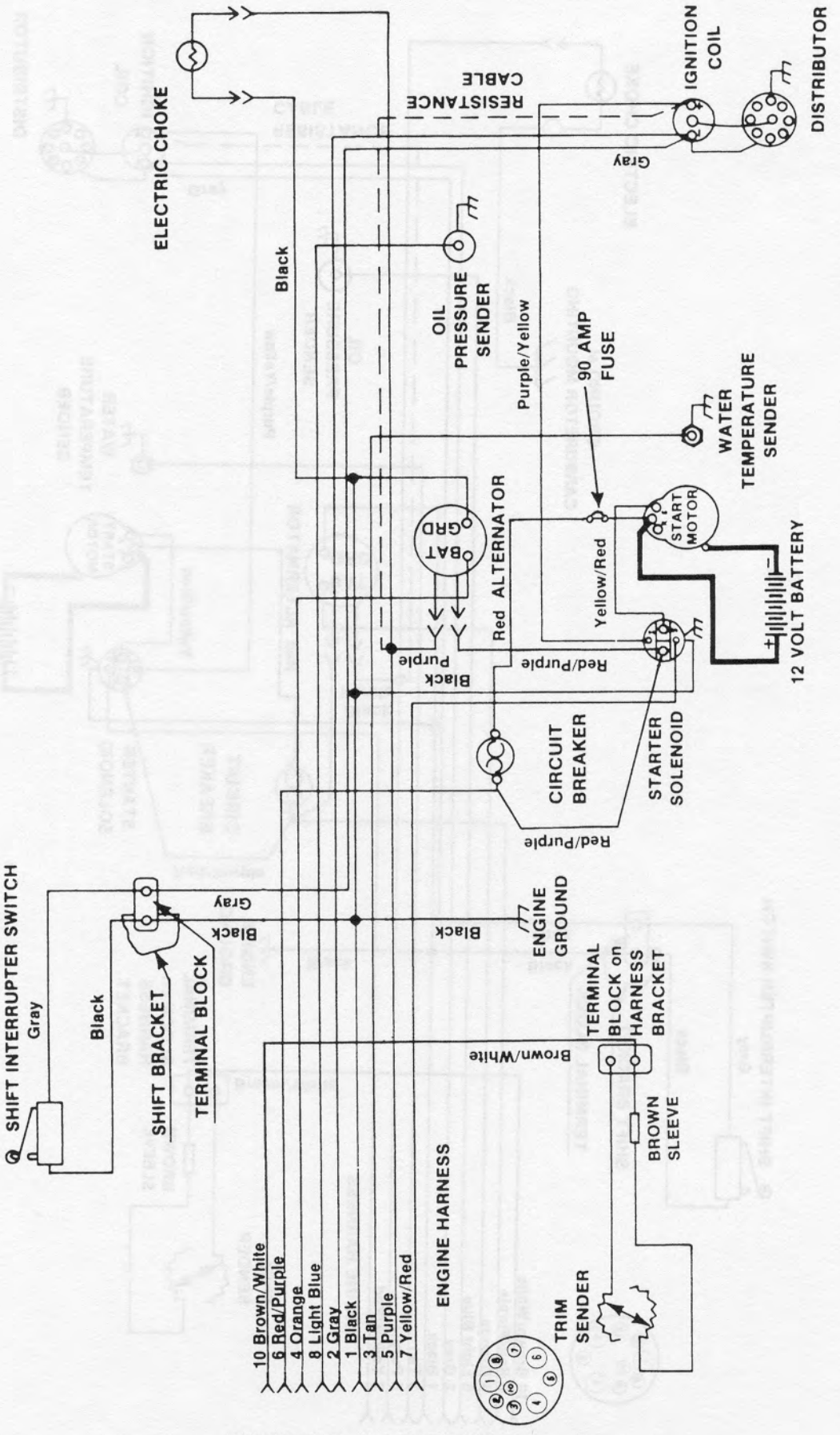
MCM 488R Engine Wiring Diagram
without 90 Amp Fuse at Starter Motor (Orange Wire)
(Battery Meter Circuit)



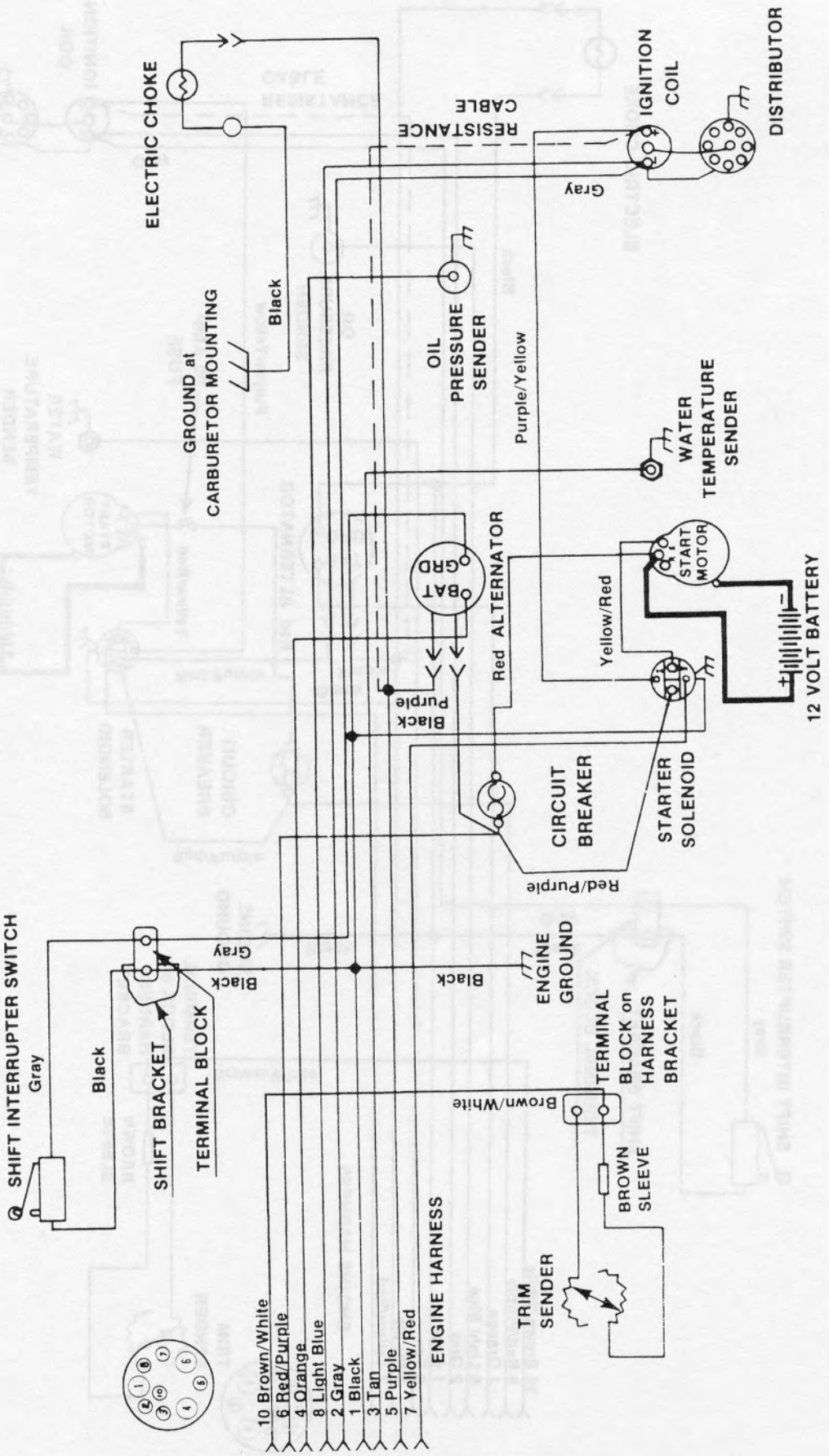
MCM 898 Engine Wiring Diagram
Pre BIA Color Code with 55 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



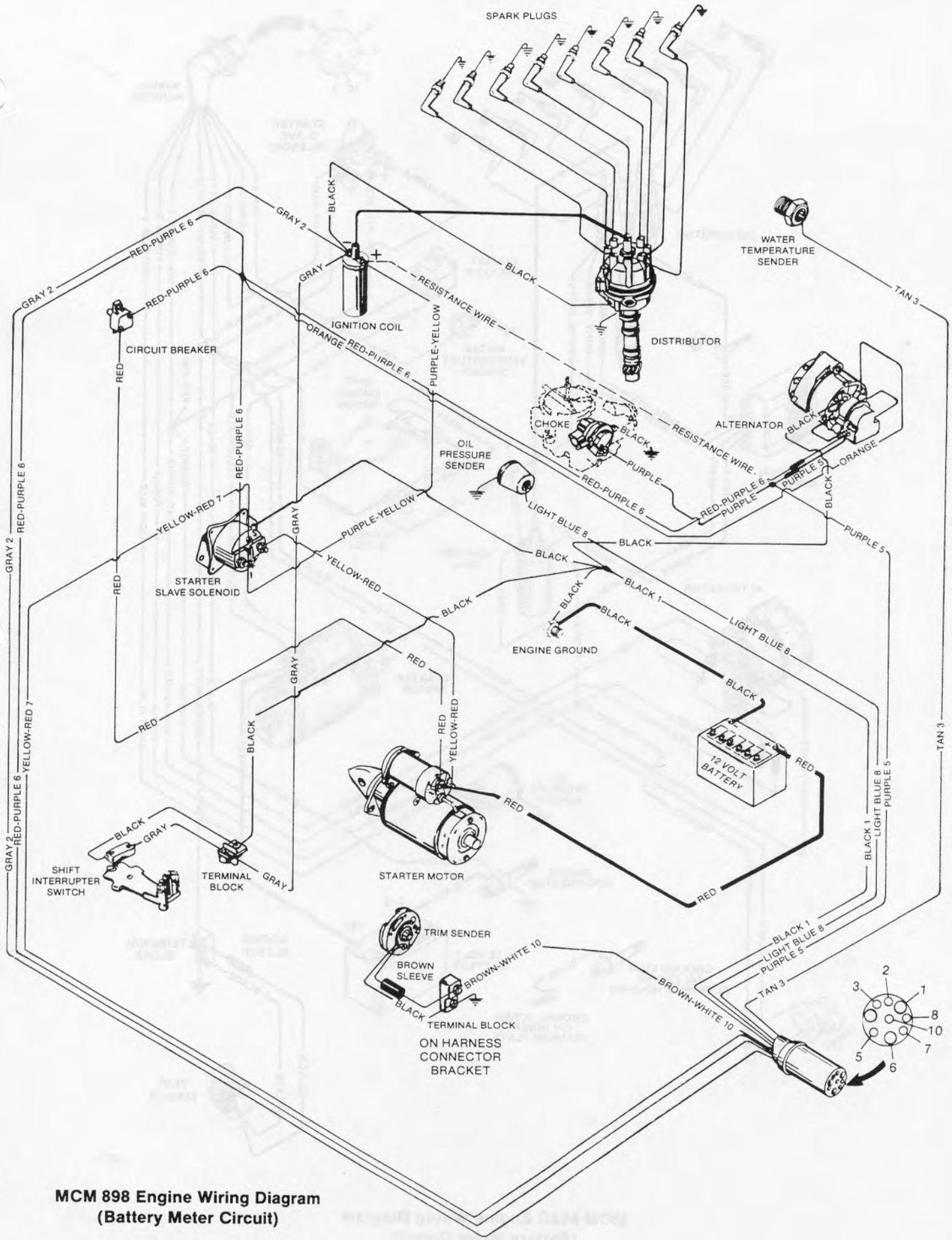
MCM 898 Engine Wiring Diagram
Pre BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



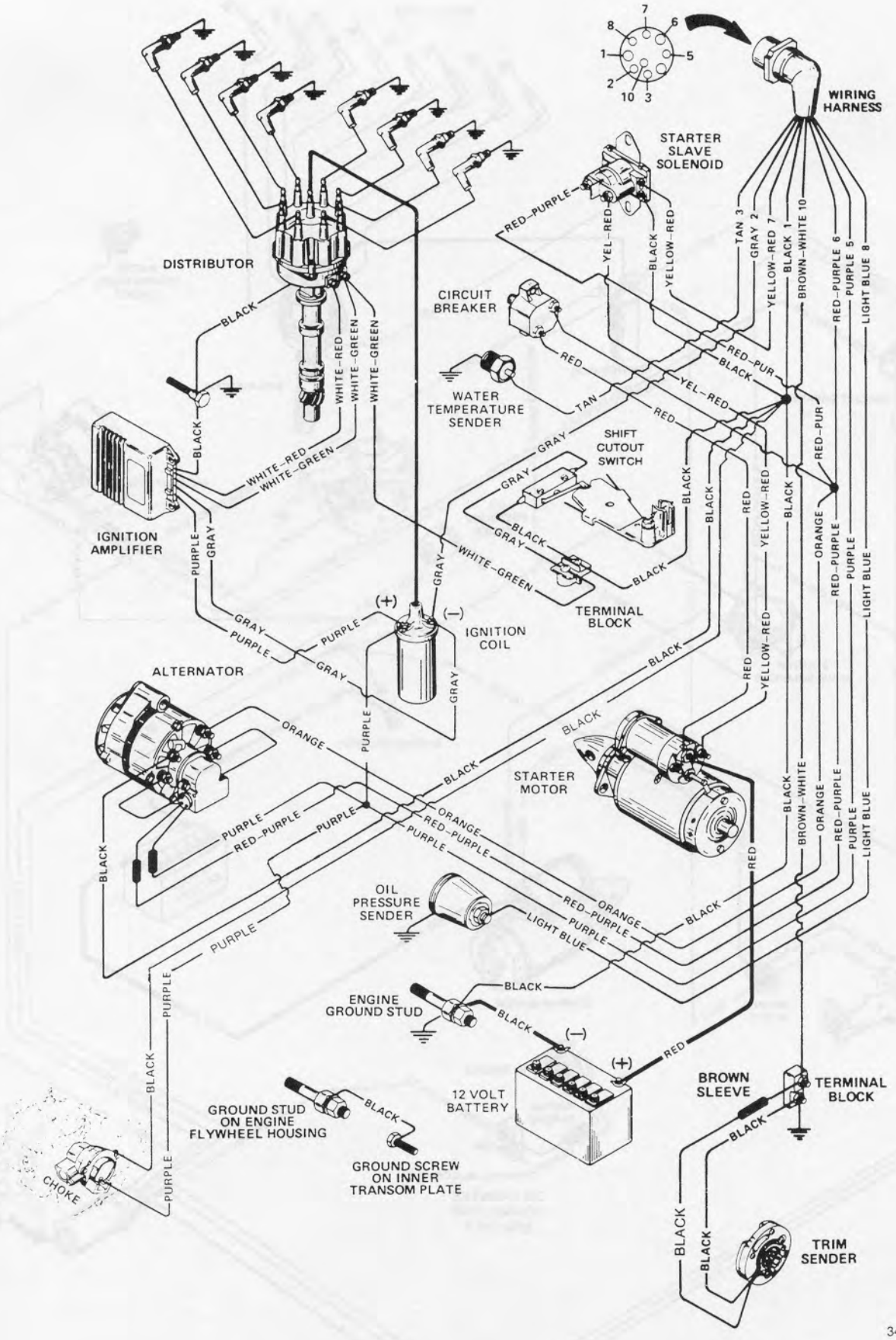
MCM 898 Engine Wiring Diagram
BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



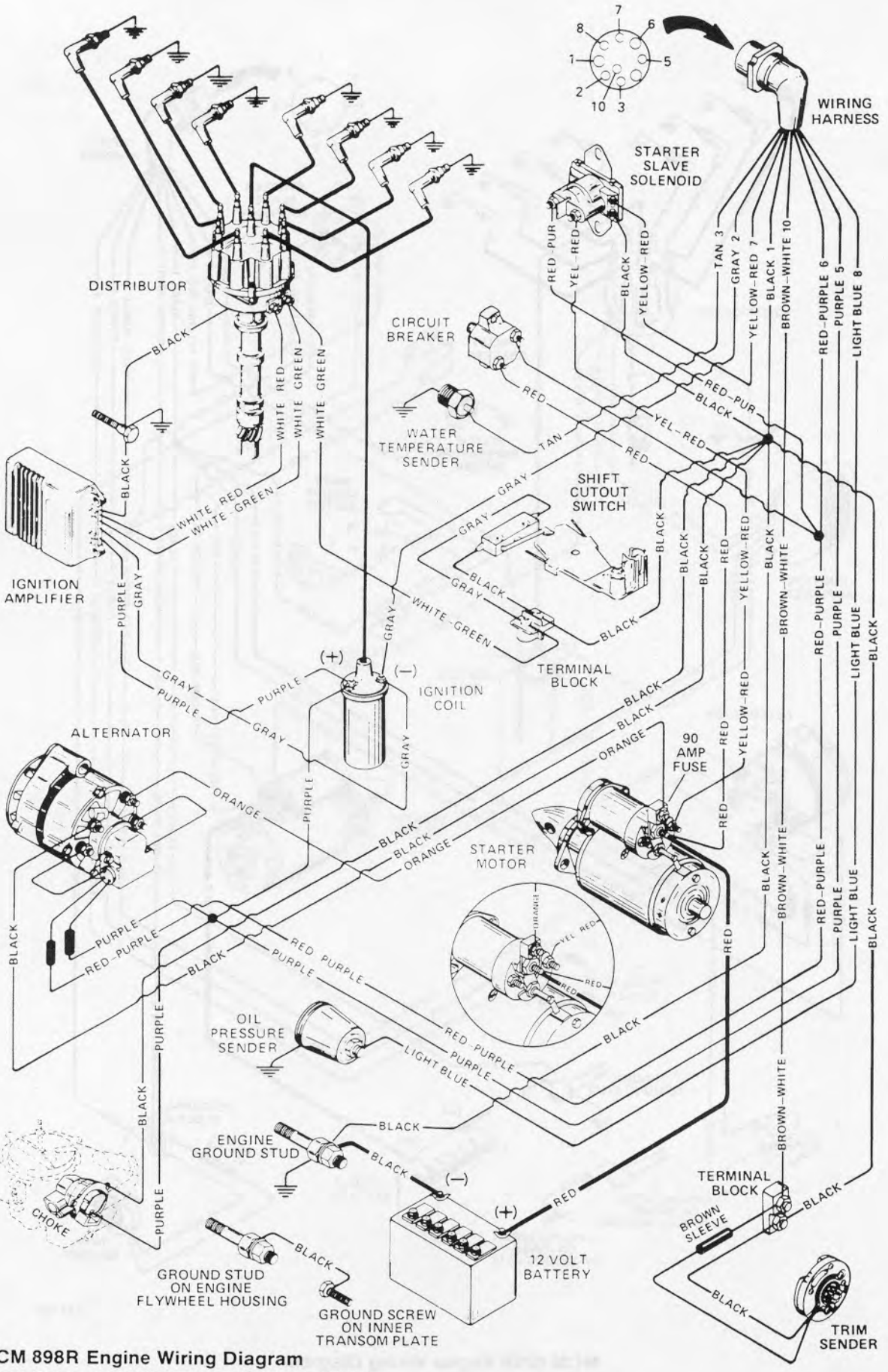
MCM 898 Engine Wiring Diagram
BIA Color Code without 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



MCM 898 Engine Wiring Diagram (Battery Meter Circuit)

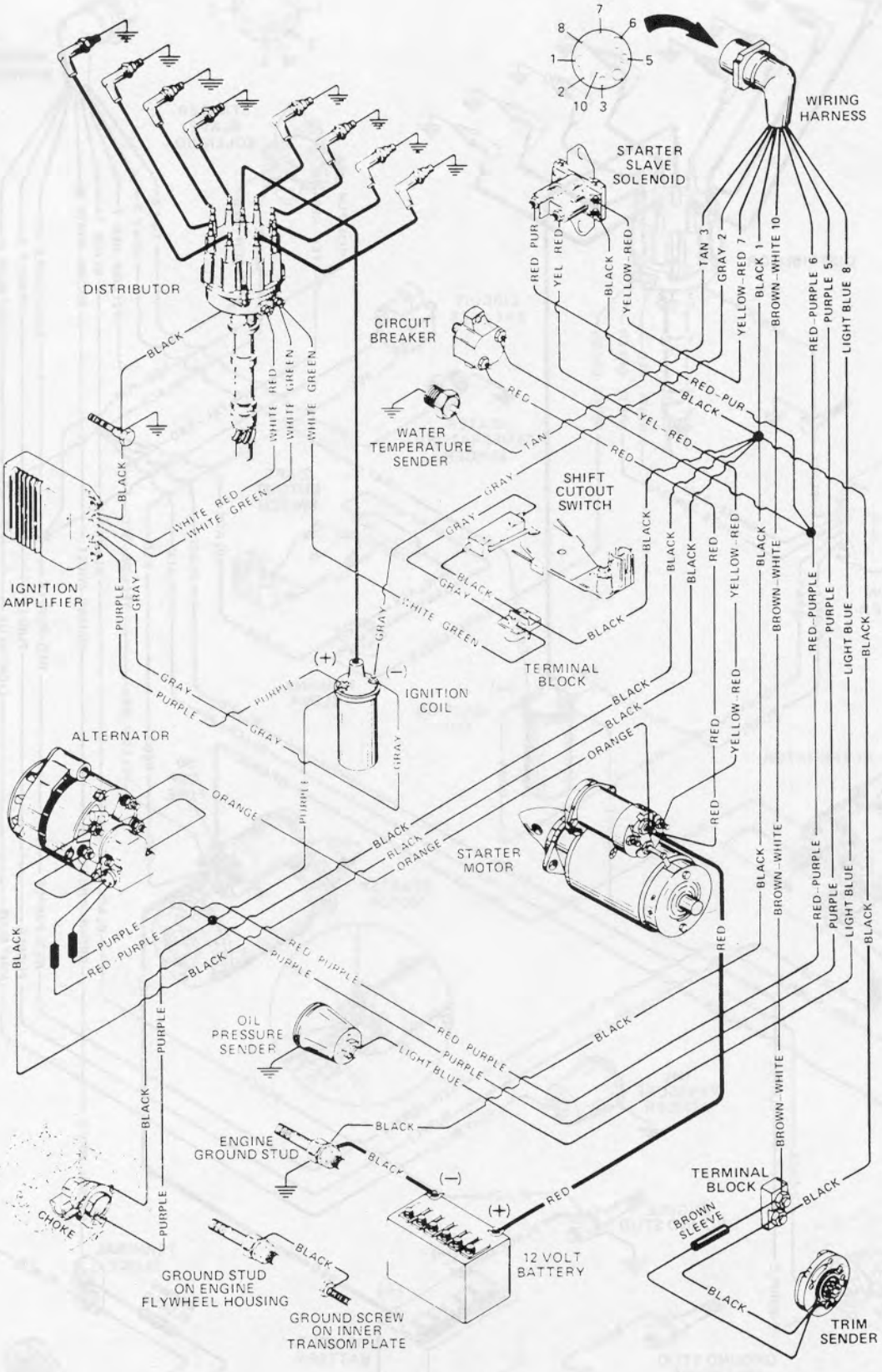


MCM 898R Engine Wiring Diagram
(Battery Meter Circuit)



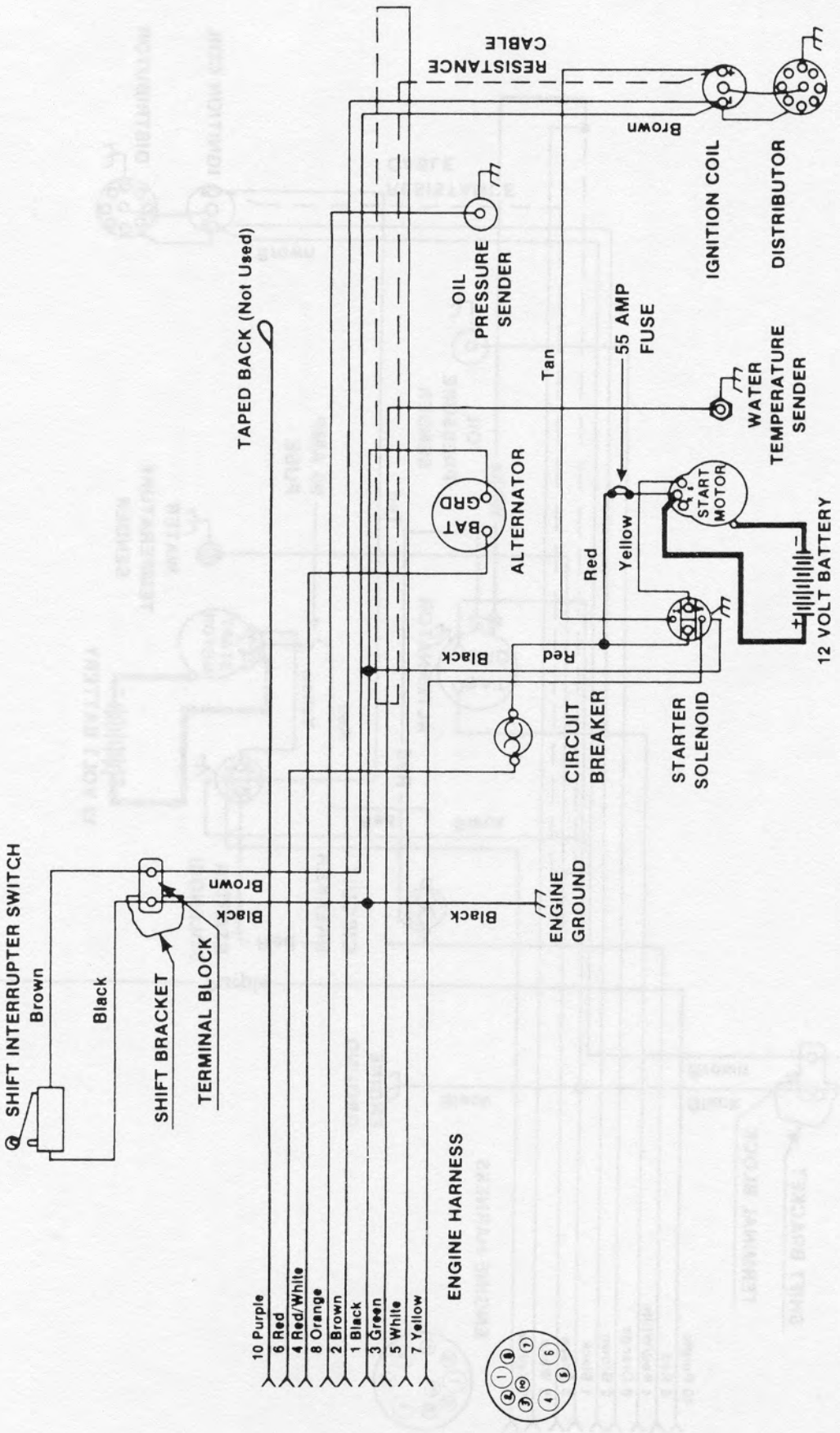
MCM 898R Engine Wiring Diagram with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

347-H

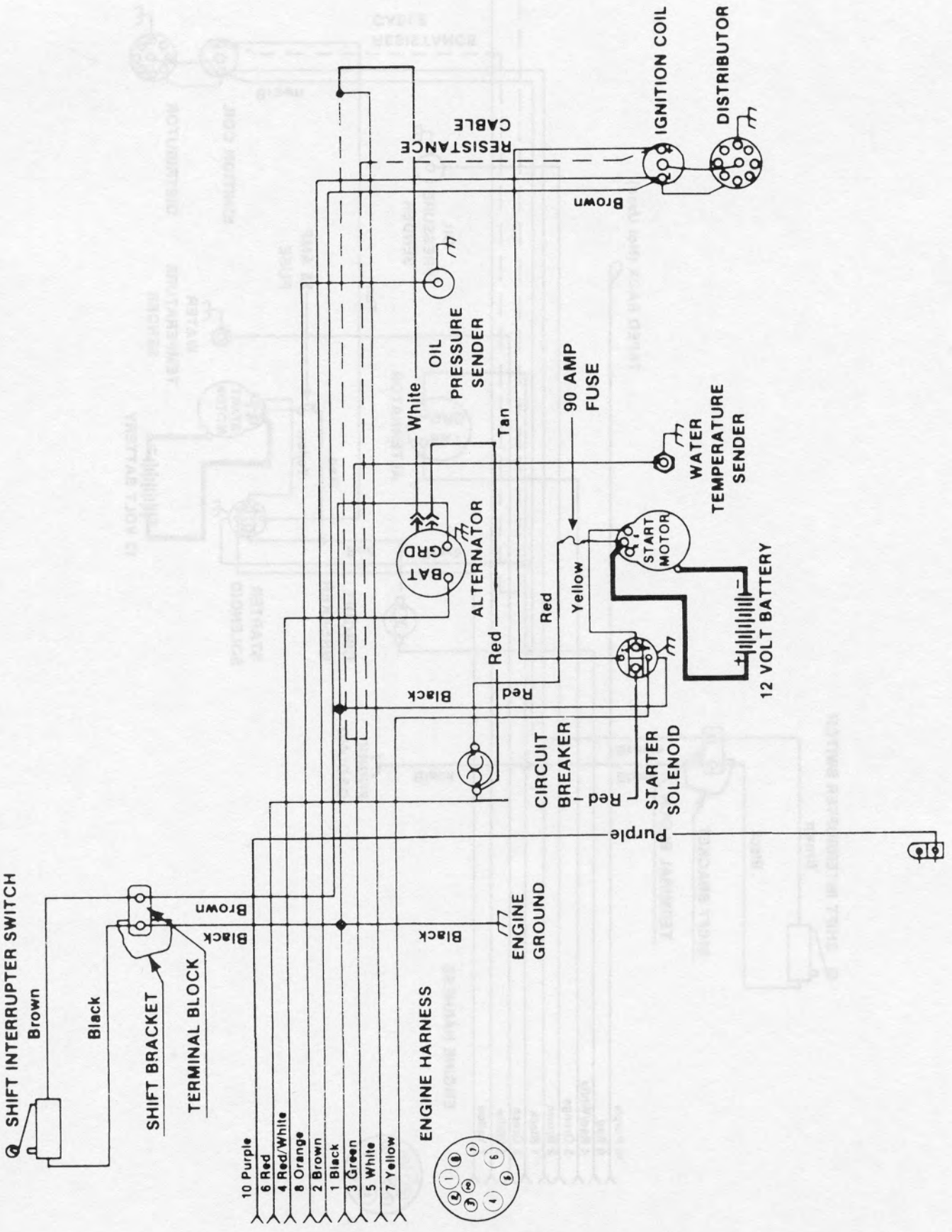


347 HR

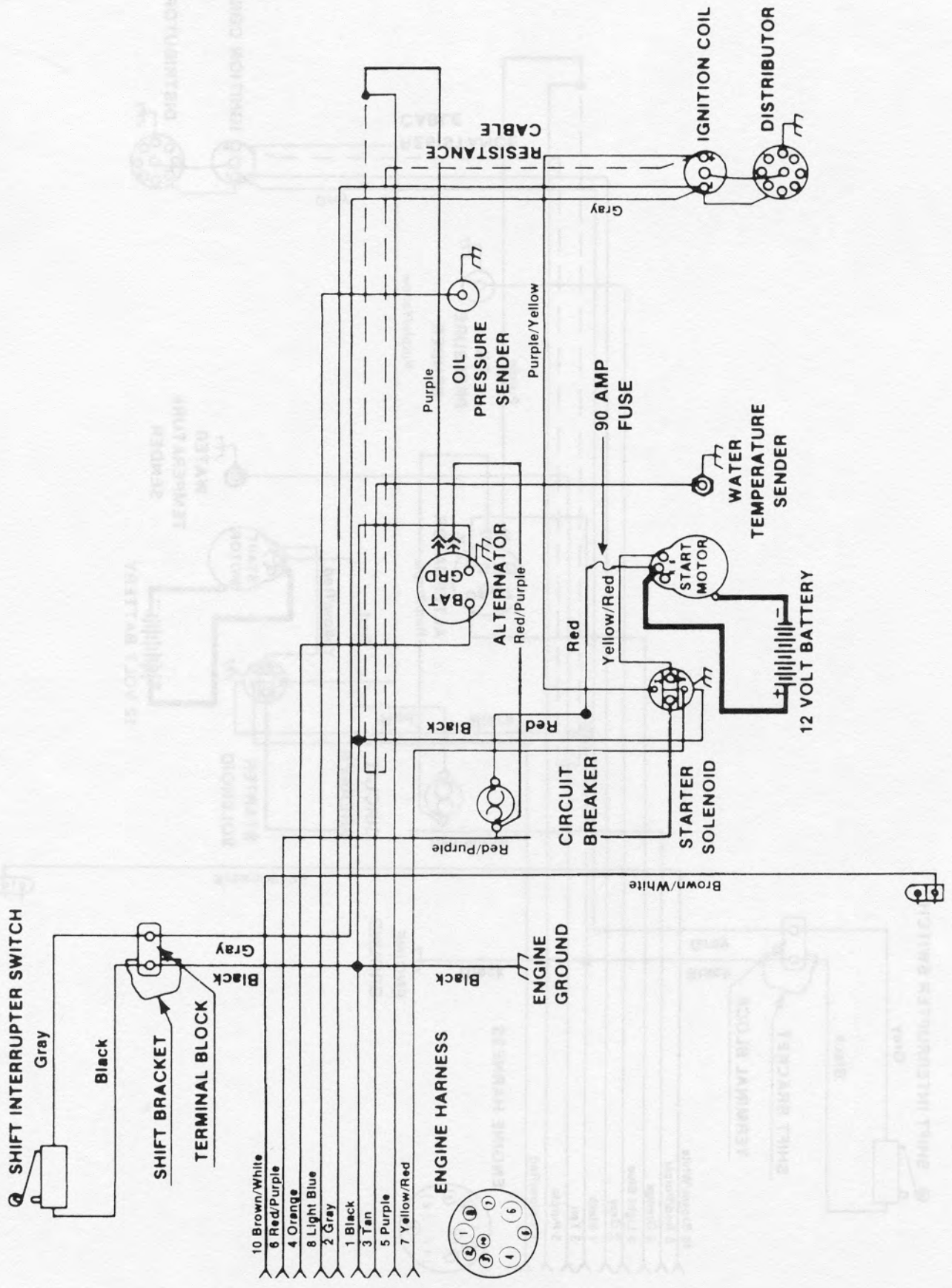
MCM 898R Engine Wiring Diagram
without 90 Amp Fuse at Starter Motor (Orange Wire)
(Battery Meter Circuit)



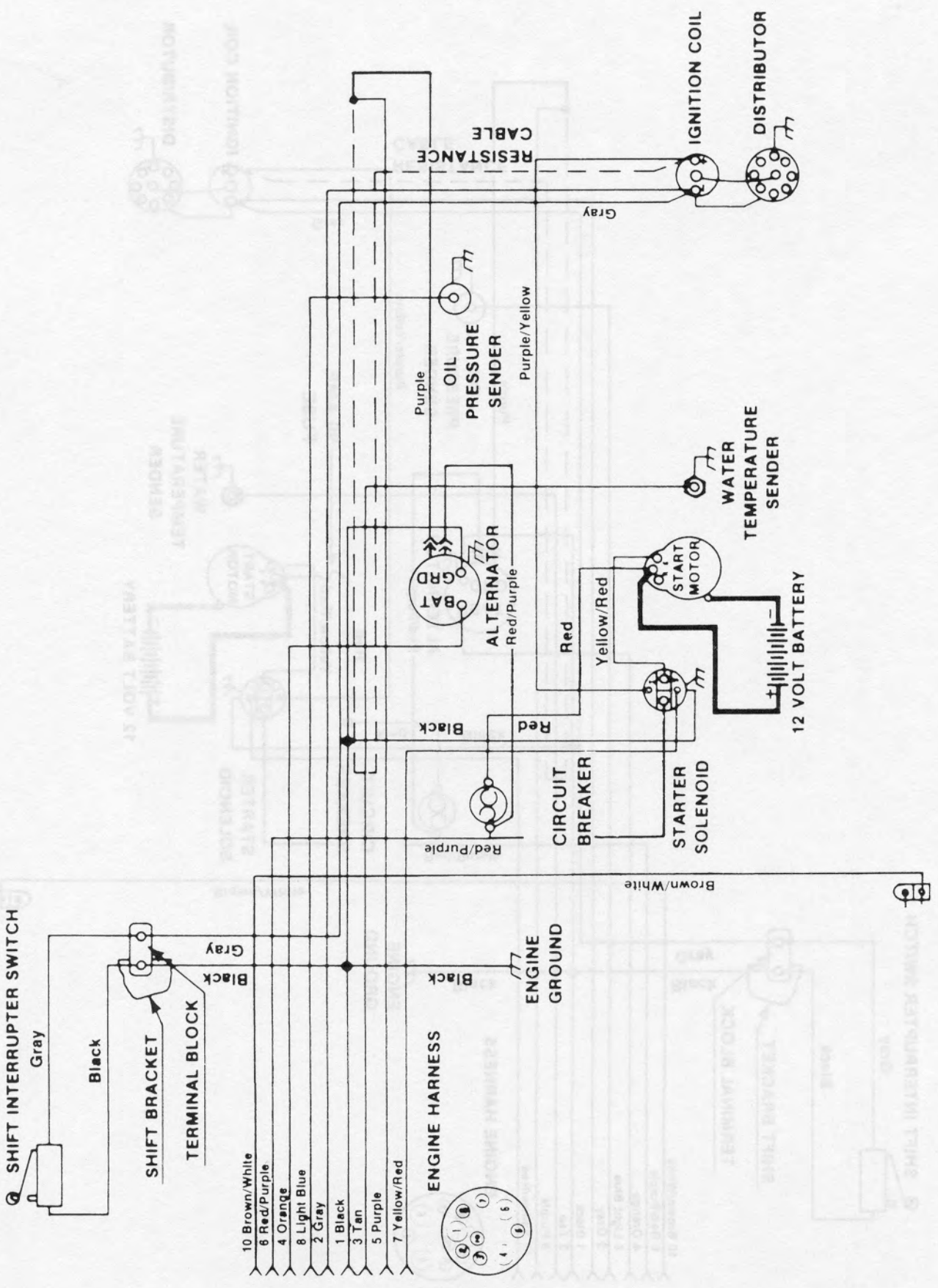
MCM 228/260 Engine Wiring Diagram
Pre BIA Color Code with 55 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



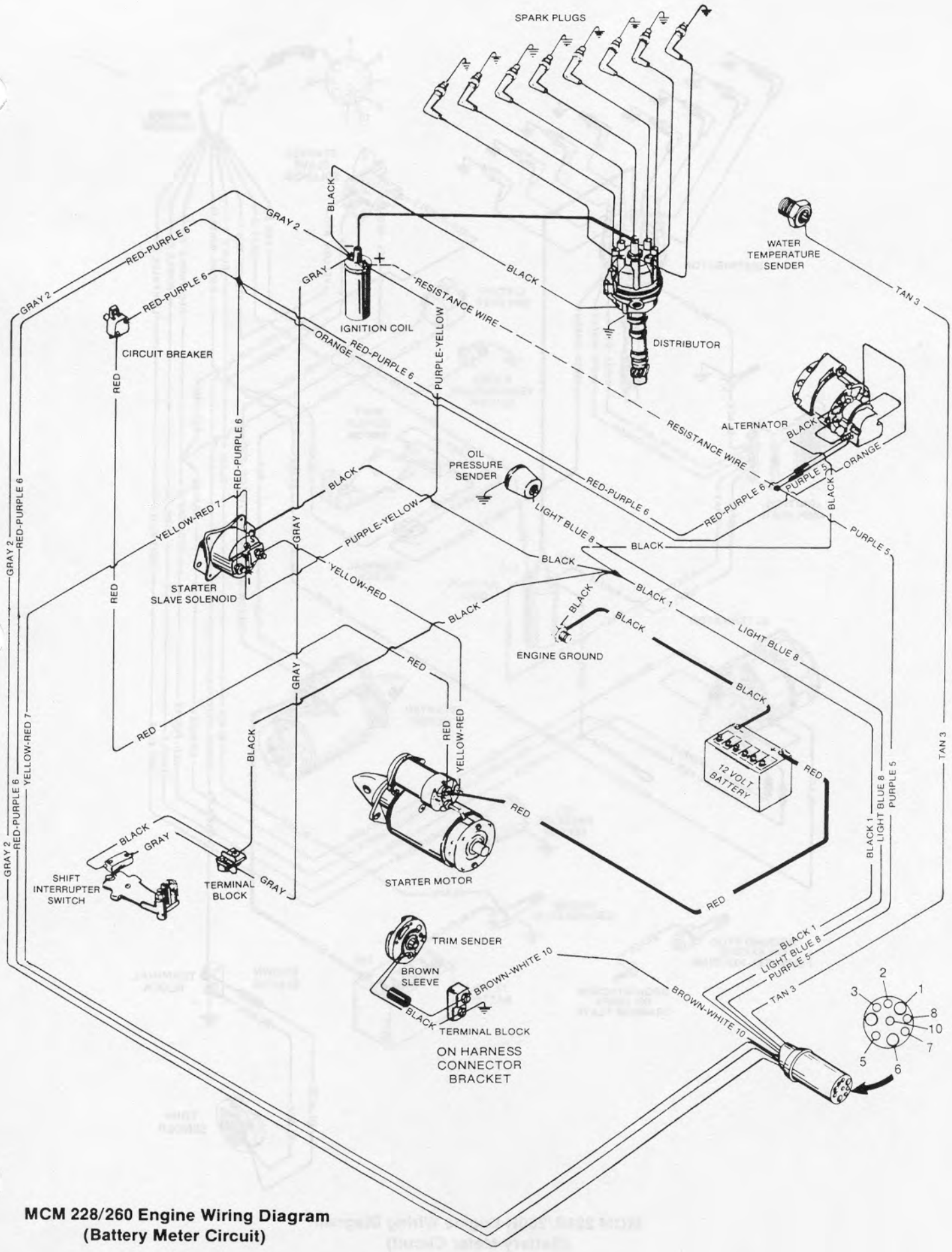
MCM 228/260 Engine Wiring Diagram
Pre BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



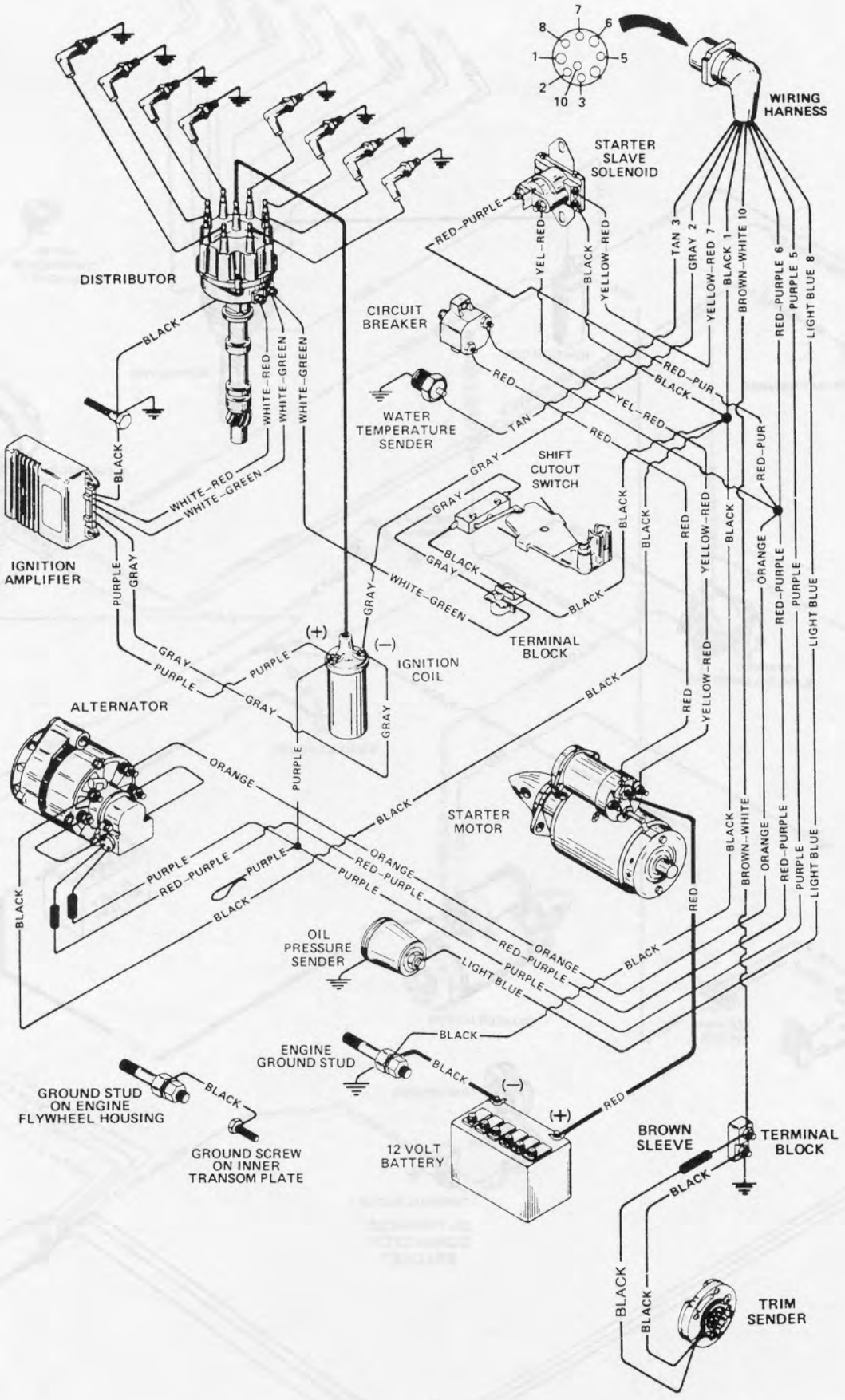
MCM 228/260 Engine Wiring Diagram
BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



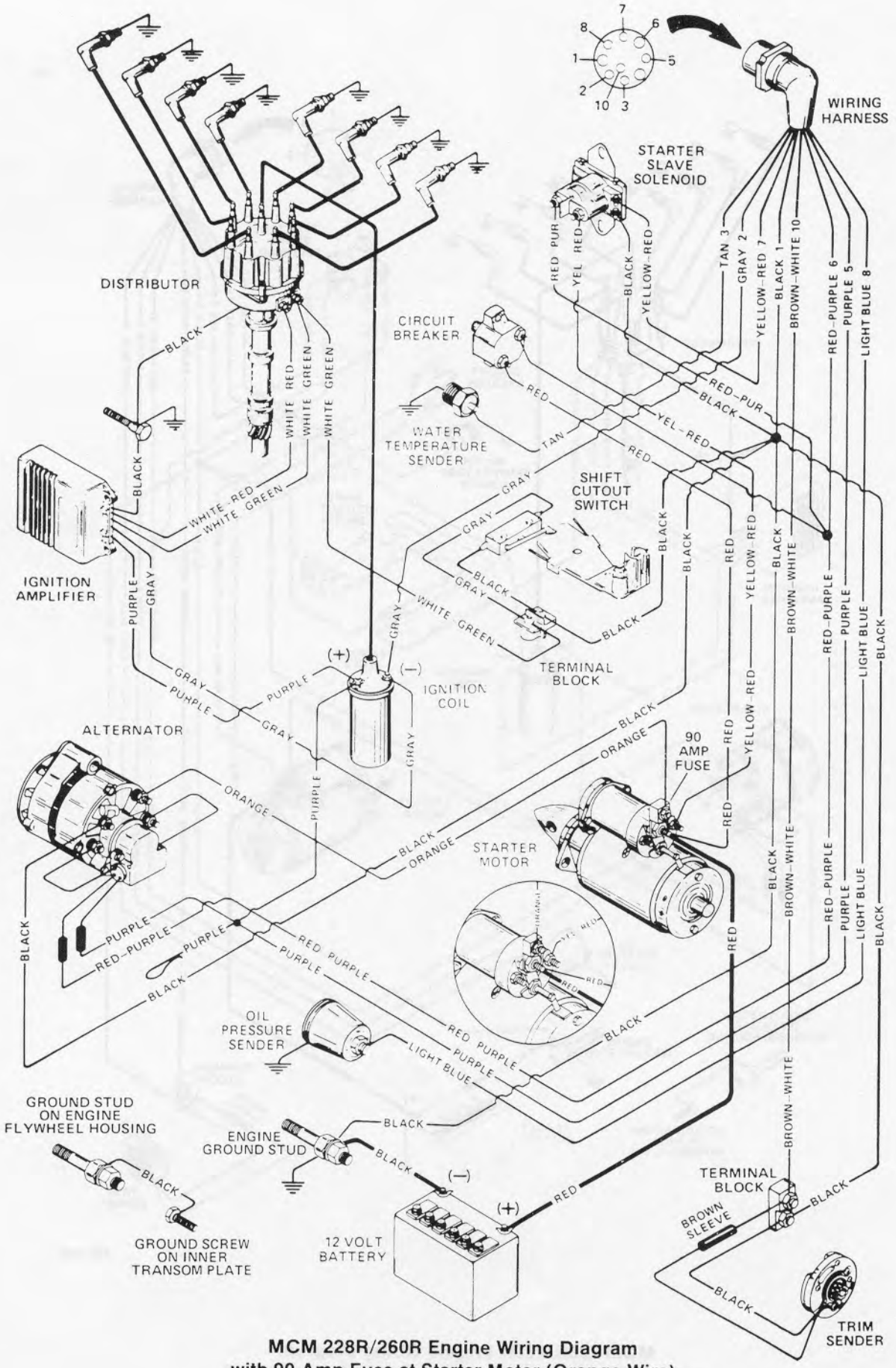
MCM 228/260 Engine Wiring Diagram
BIA Color Code without 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



MCM 228/260 Engine Wiring Diagram
(Battery Meter Circuit)

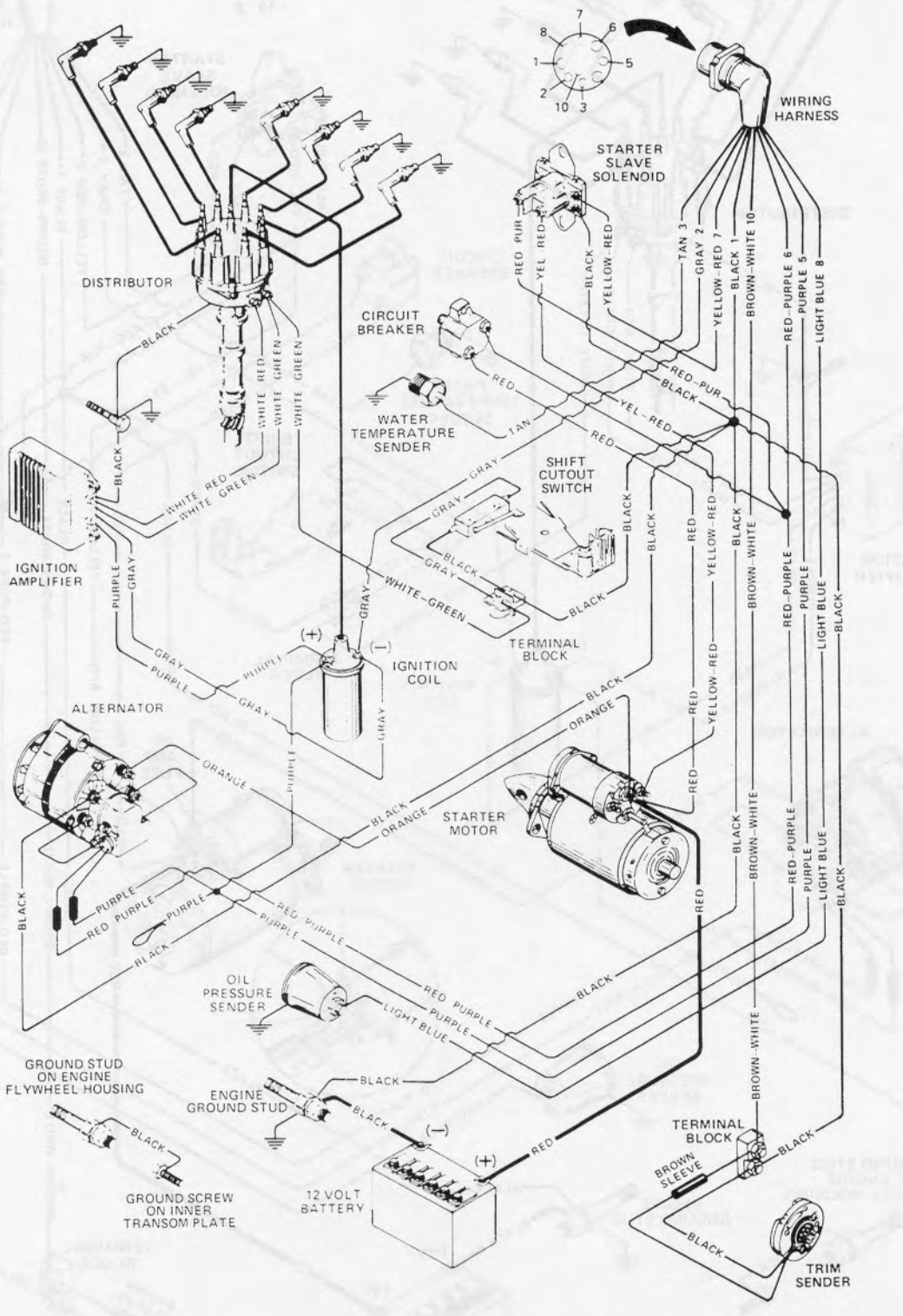


MCM 228R/260R Engine Wiring Diagram
(Battery Meter Circuit)

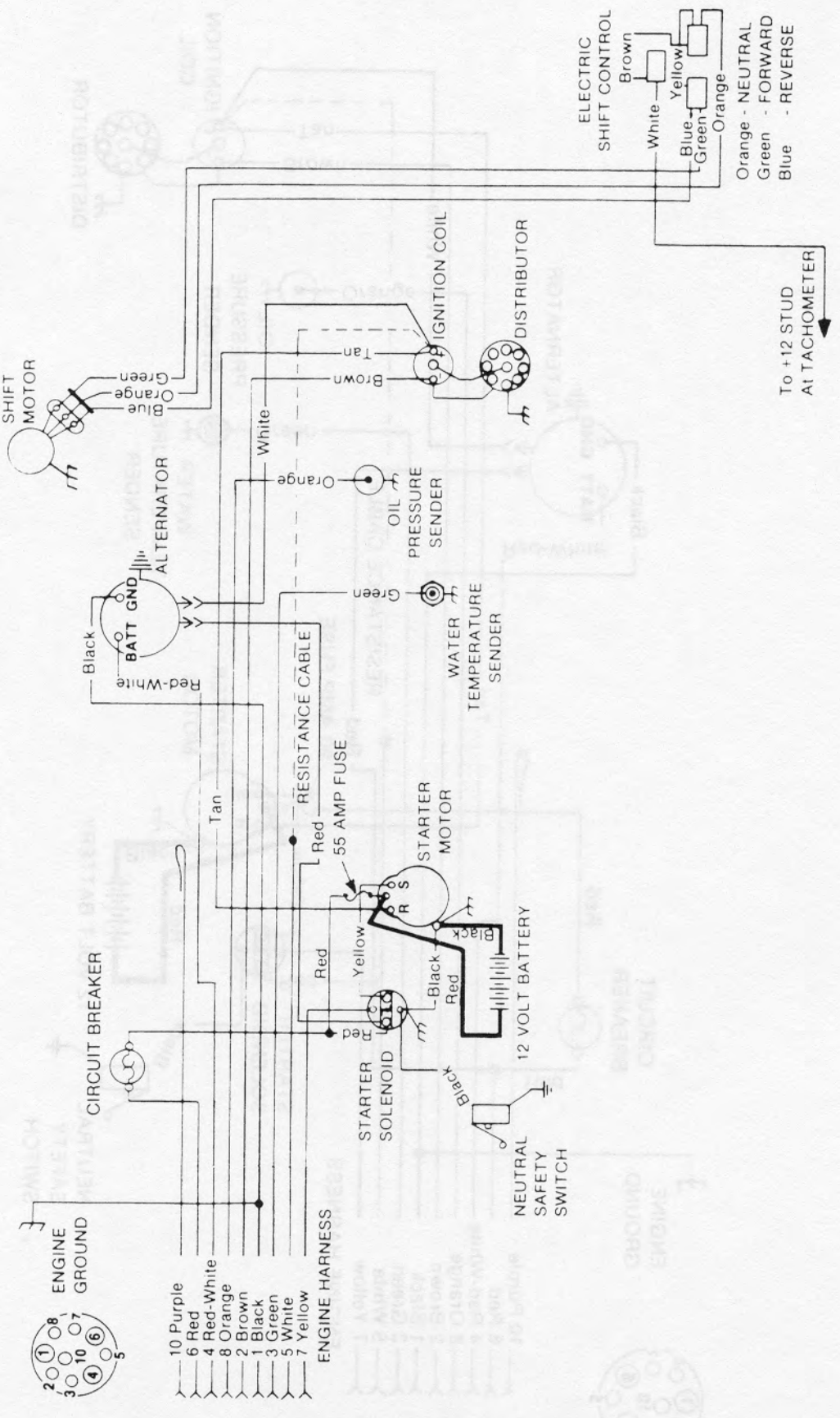


MCM 228R/260R Engine Wiring Diagram
with 90 Amp Fuse at Starter Motor (Orange Wire)
(Battery Meter Circuit)

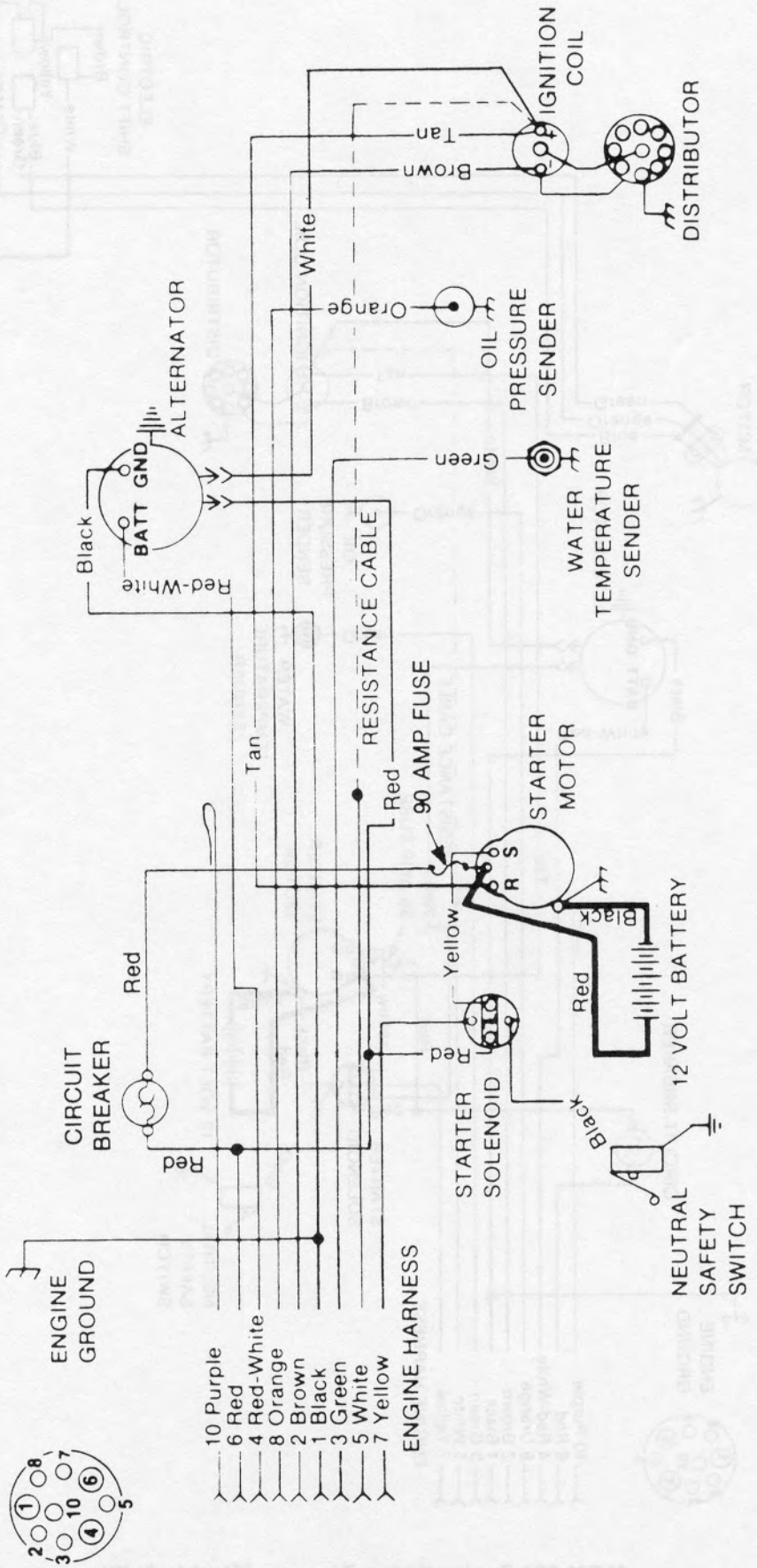
335-HR



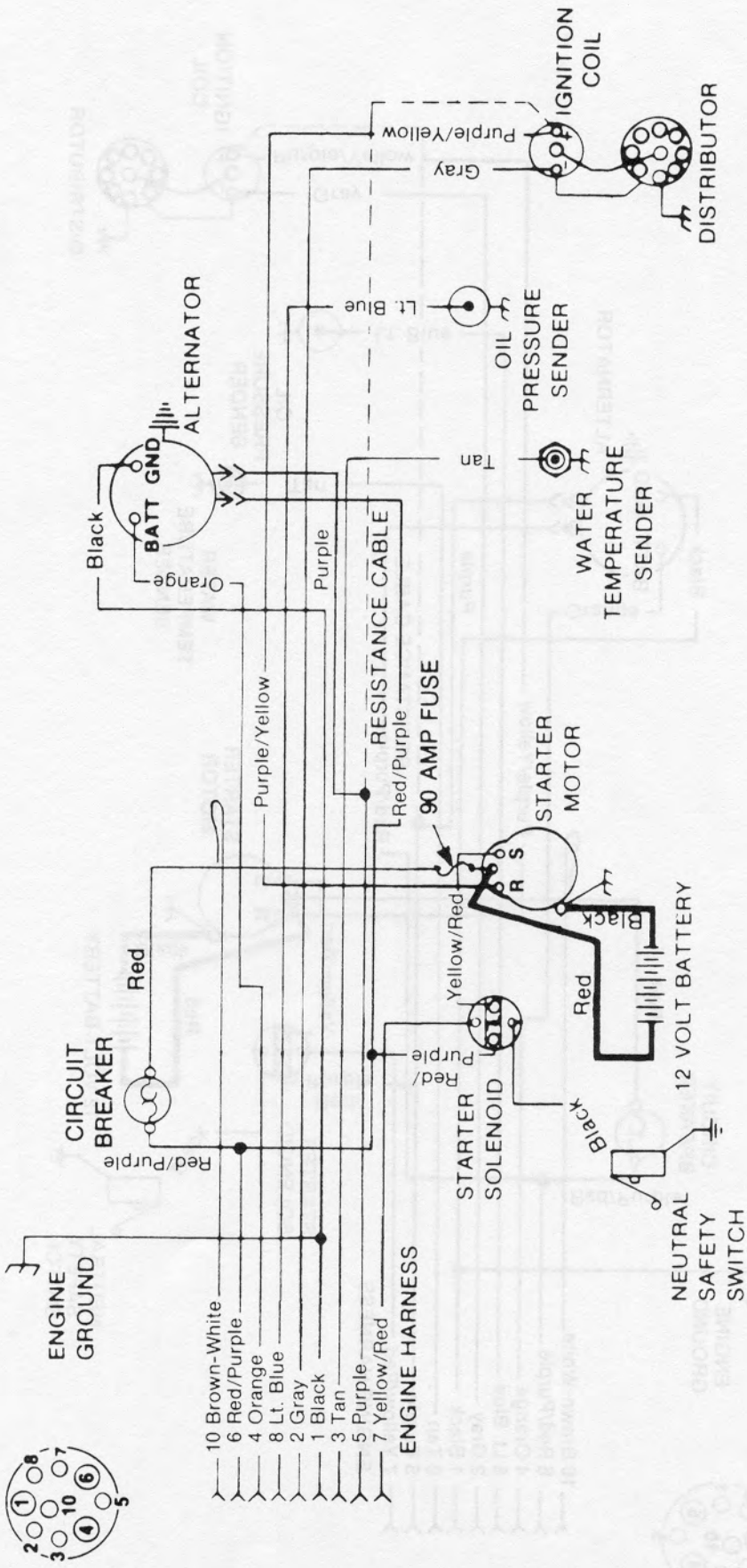
MCM 228R/260R Engine Wiring Diagram
without 90 Amp Fuse at Starter Motor (Orange Wire)
(Battery Meter Circuit)



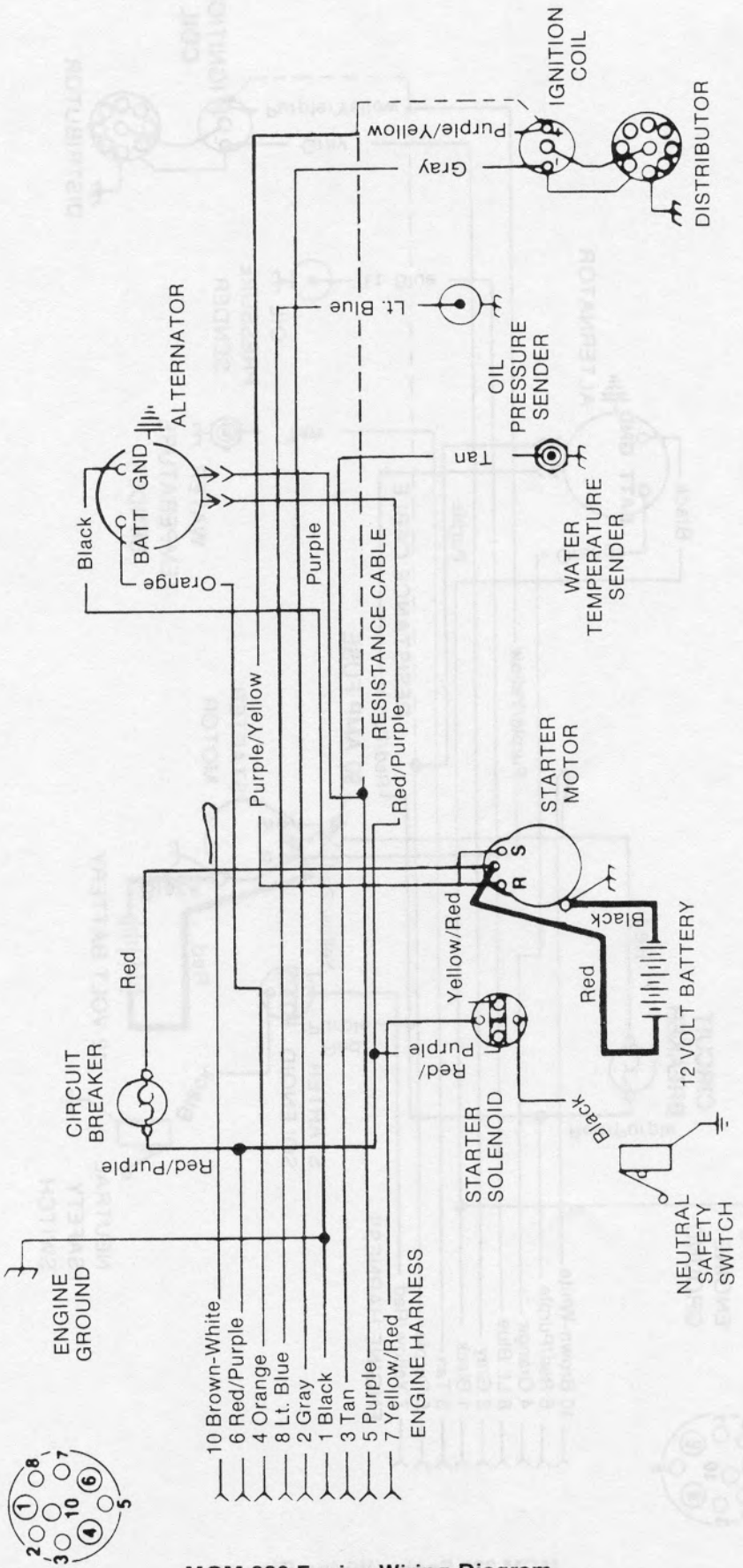
MCM 330 Engine Wiring Diagram (Electric Shift)
Pre BIA Color Code with 55 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



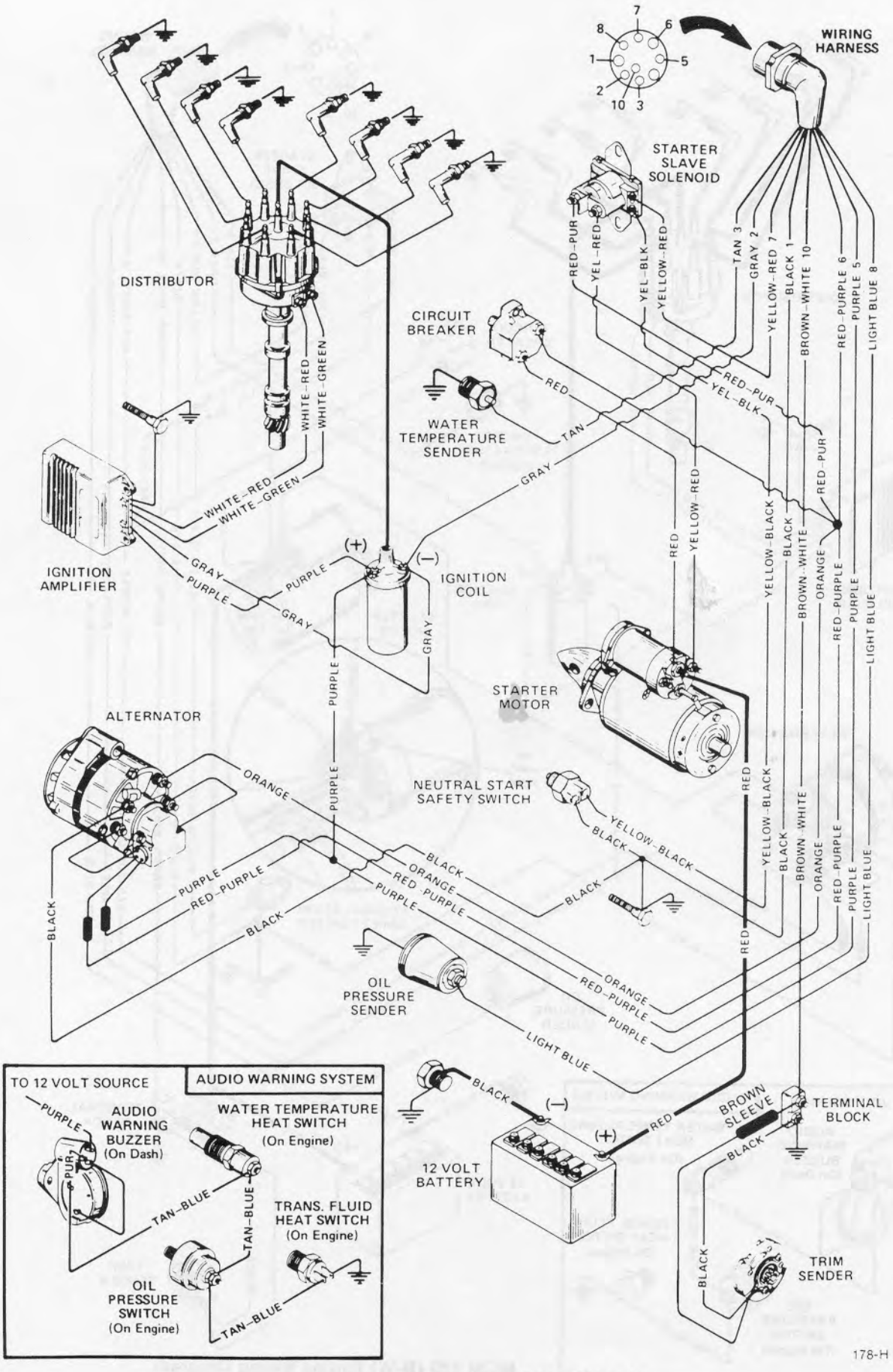
MCM 330 Engine Wiring Diagram
Pre BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



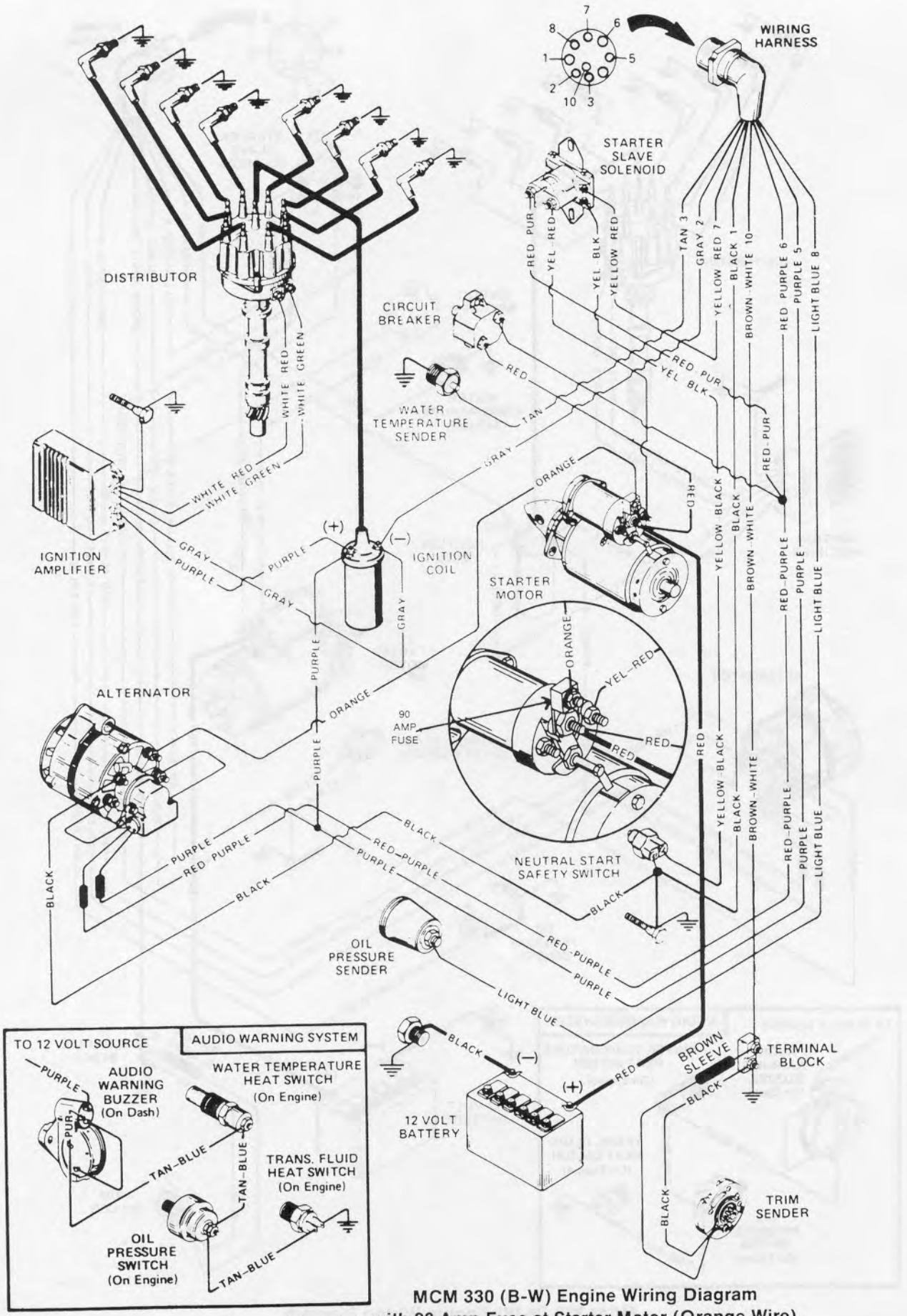
MCM 330 Engine Wiring Diagram
BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



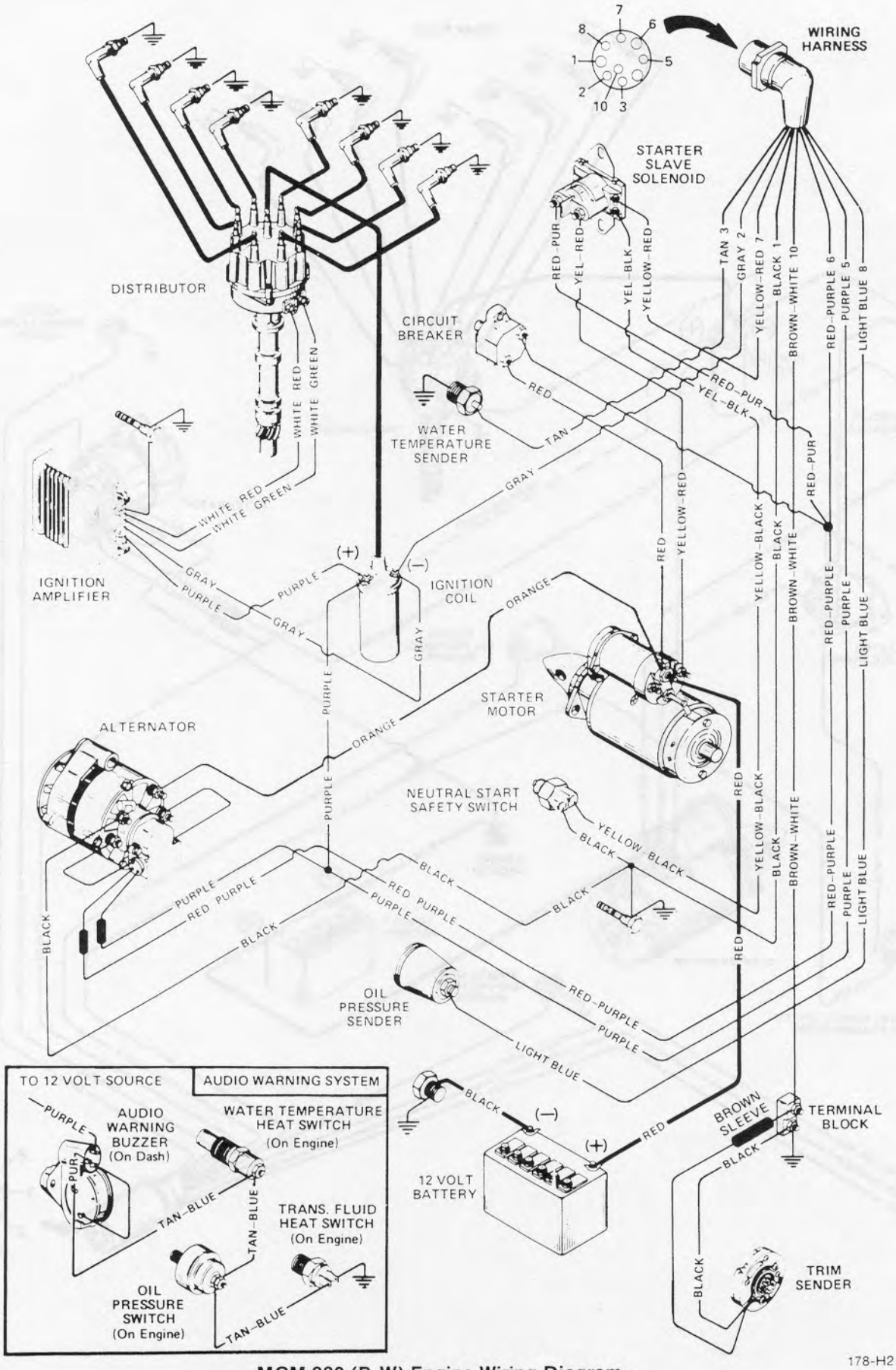
MCM 330 Engine Wiring Diagram
BIA Color Code without 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



MCM 330 (B-W) Engine Wiring Diagram
(Battery Meter Circuit)

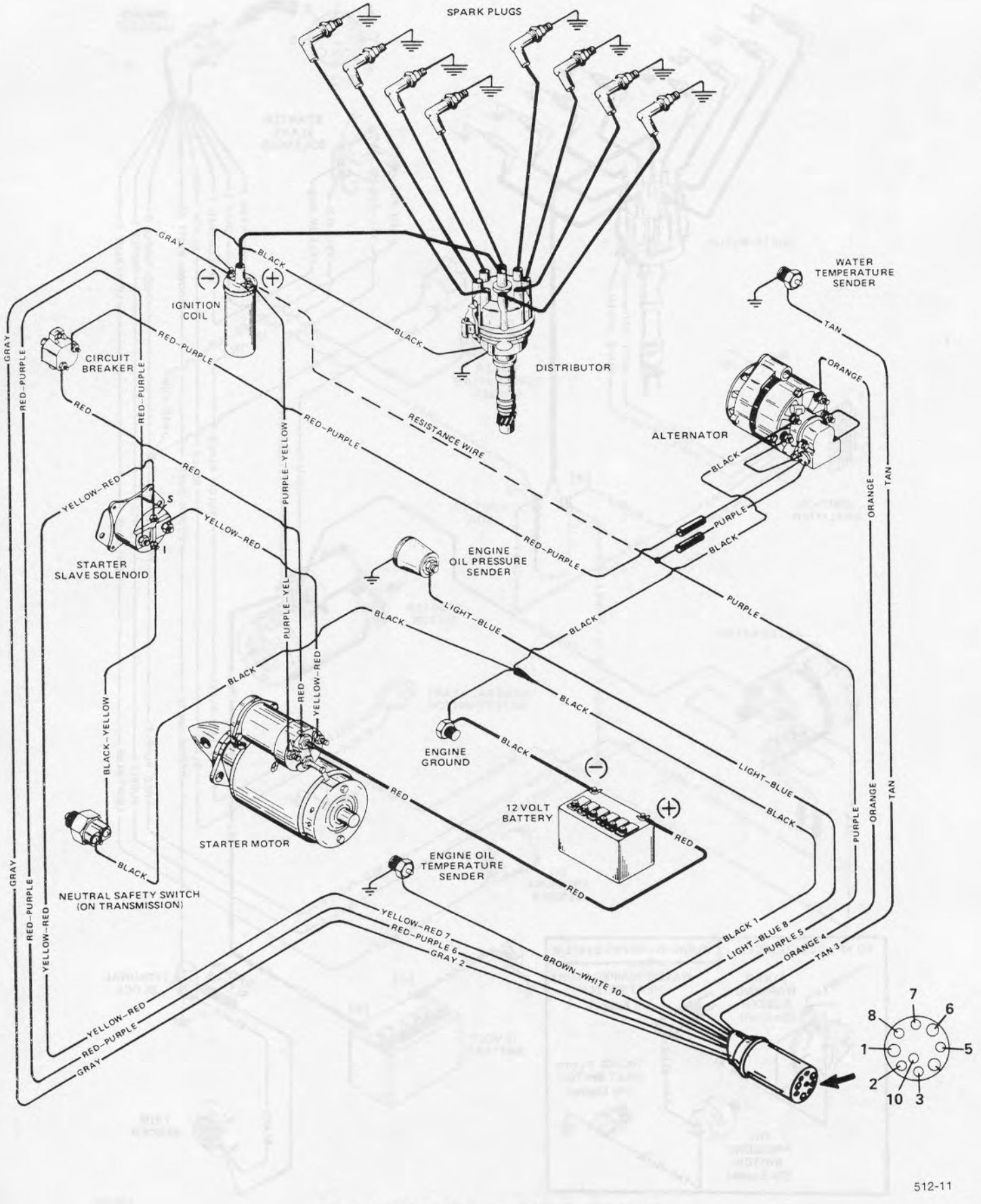


MCM 330 (B-W) Engine Wiring Diagram with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

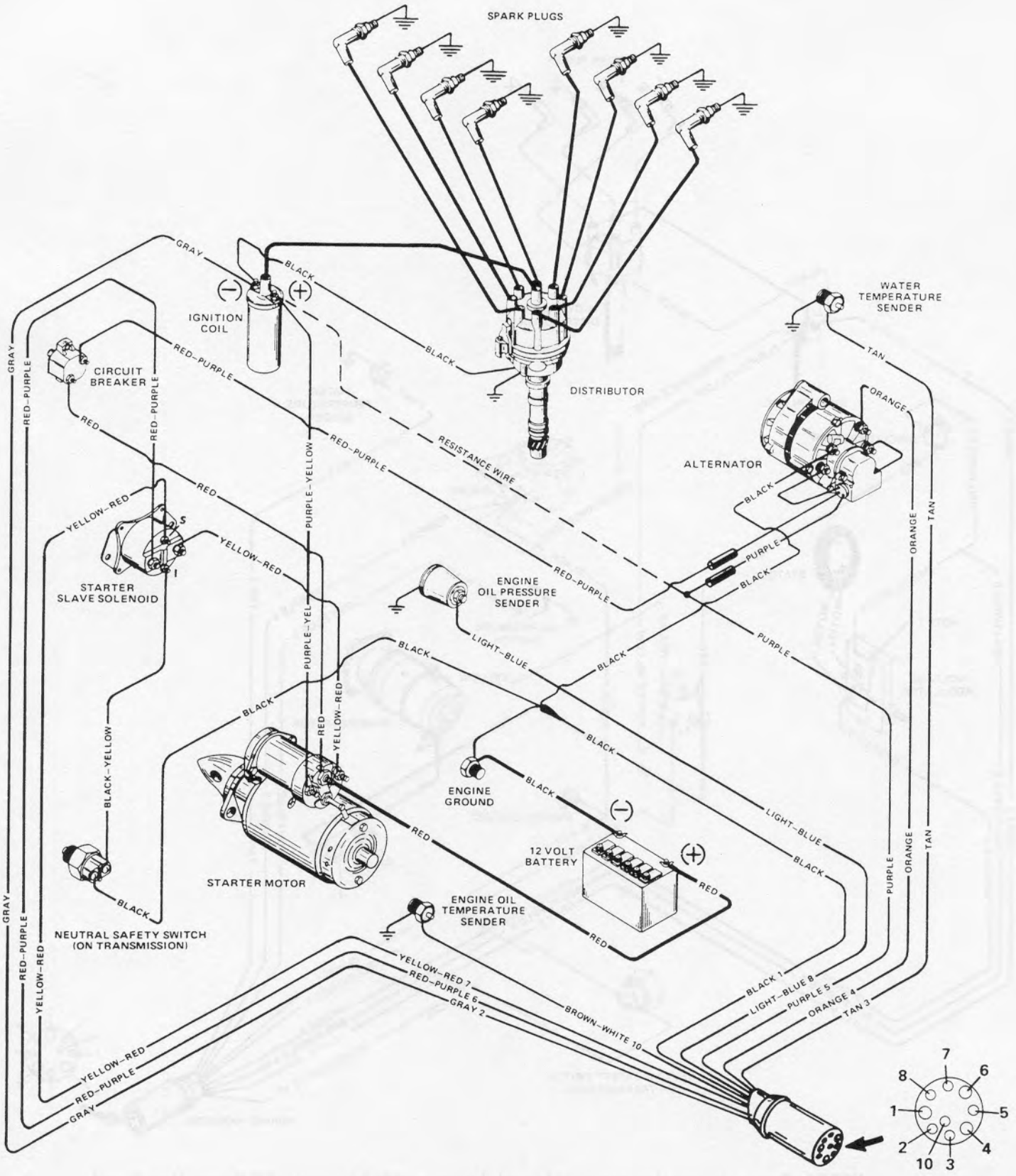


178-H2

MCM 330 (B-W) Engine Wiring Diagram without 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

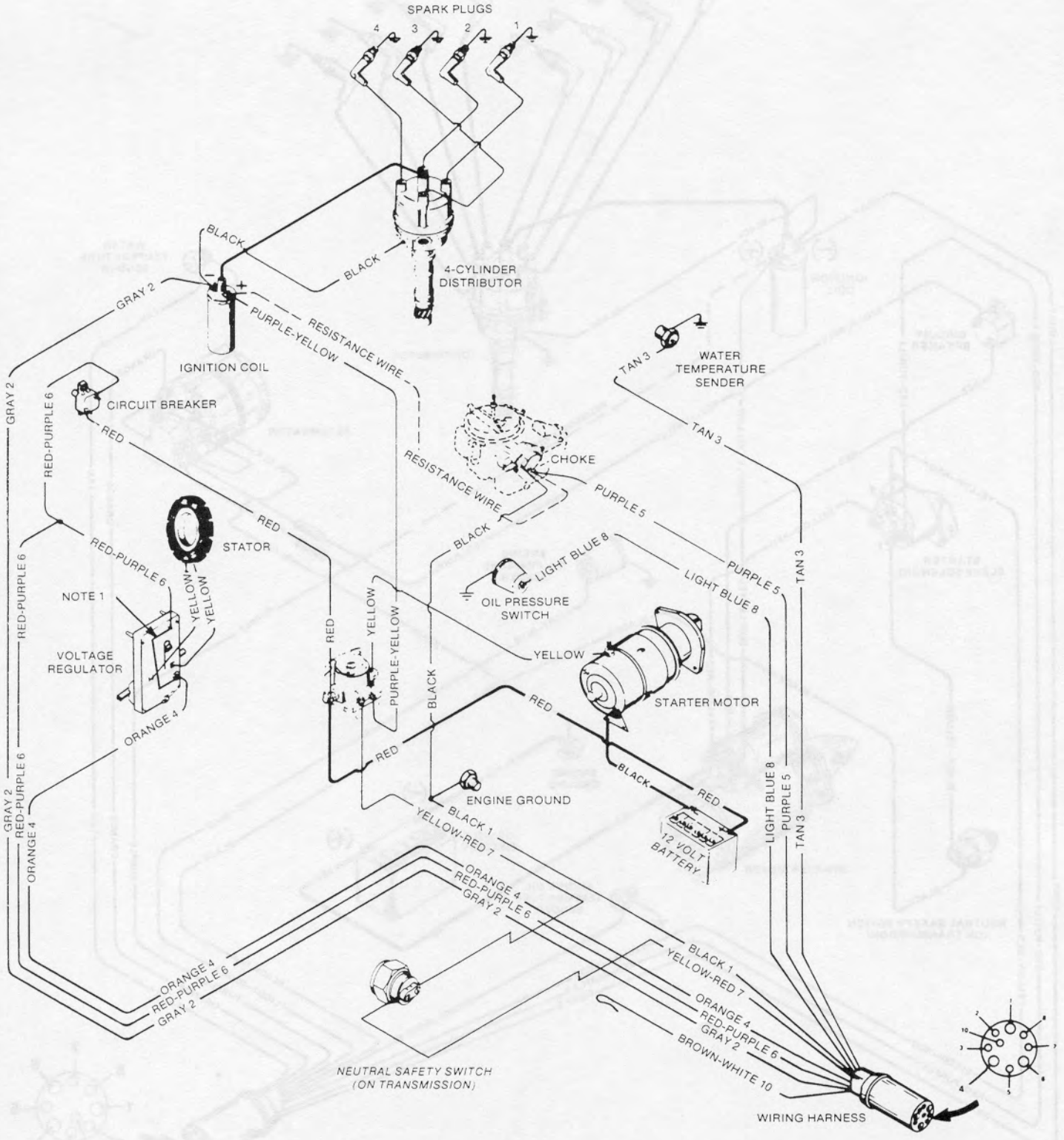


MCM 370/400TRS Engine Wiring Diagram
BIA Color Code
(Ammeter Circuit)



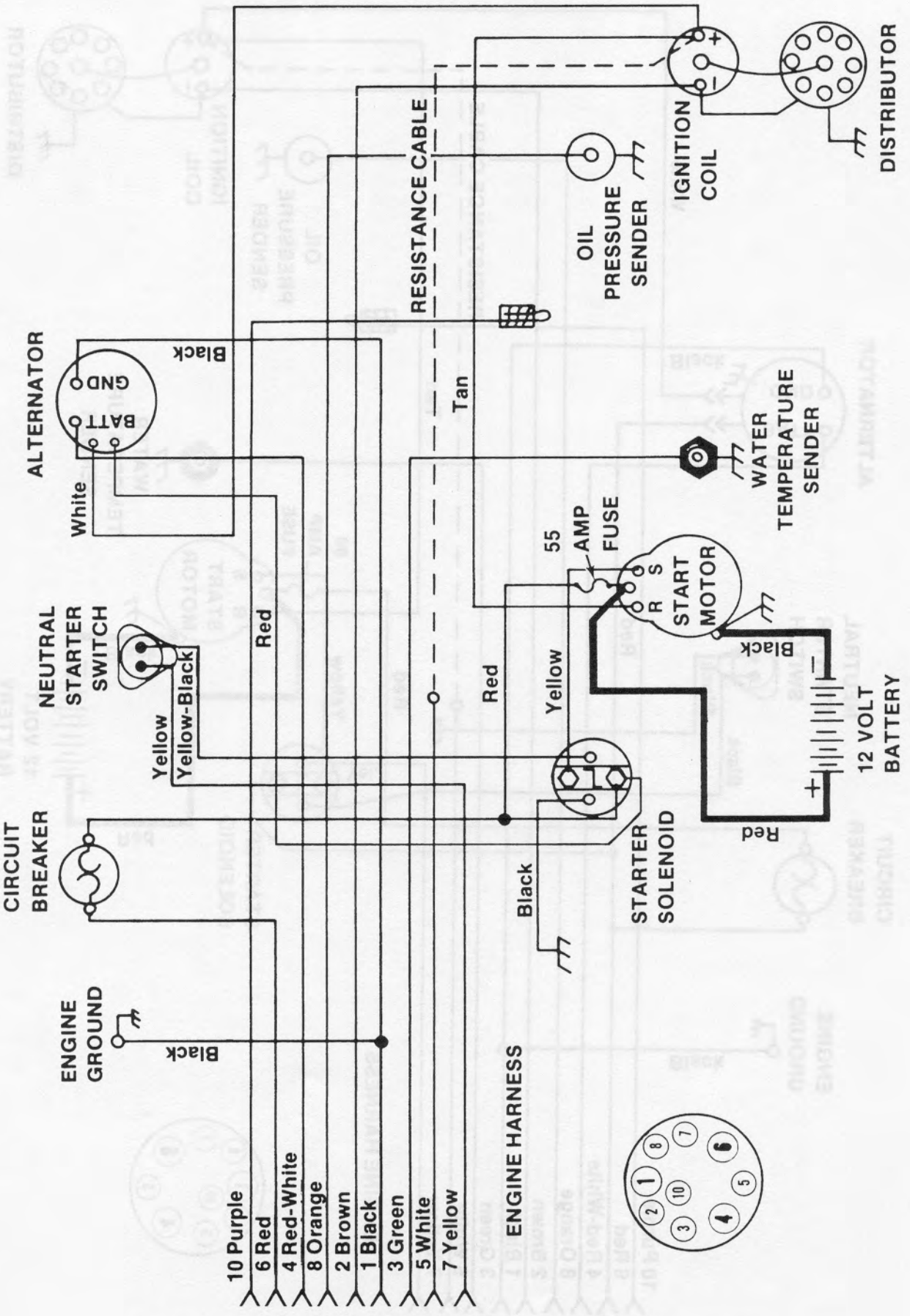
512-11

Hi-Performance MCM 400 Cyclone, 440 Cyclone, 460 Cyclone and 475 Turbo Engine Wiring Diagram
BIA Color Code (Ammeter Circuit)

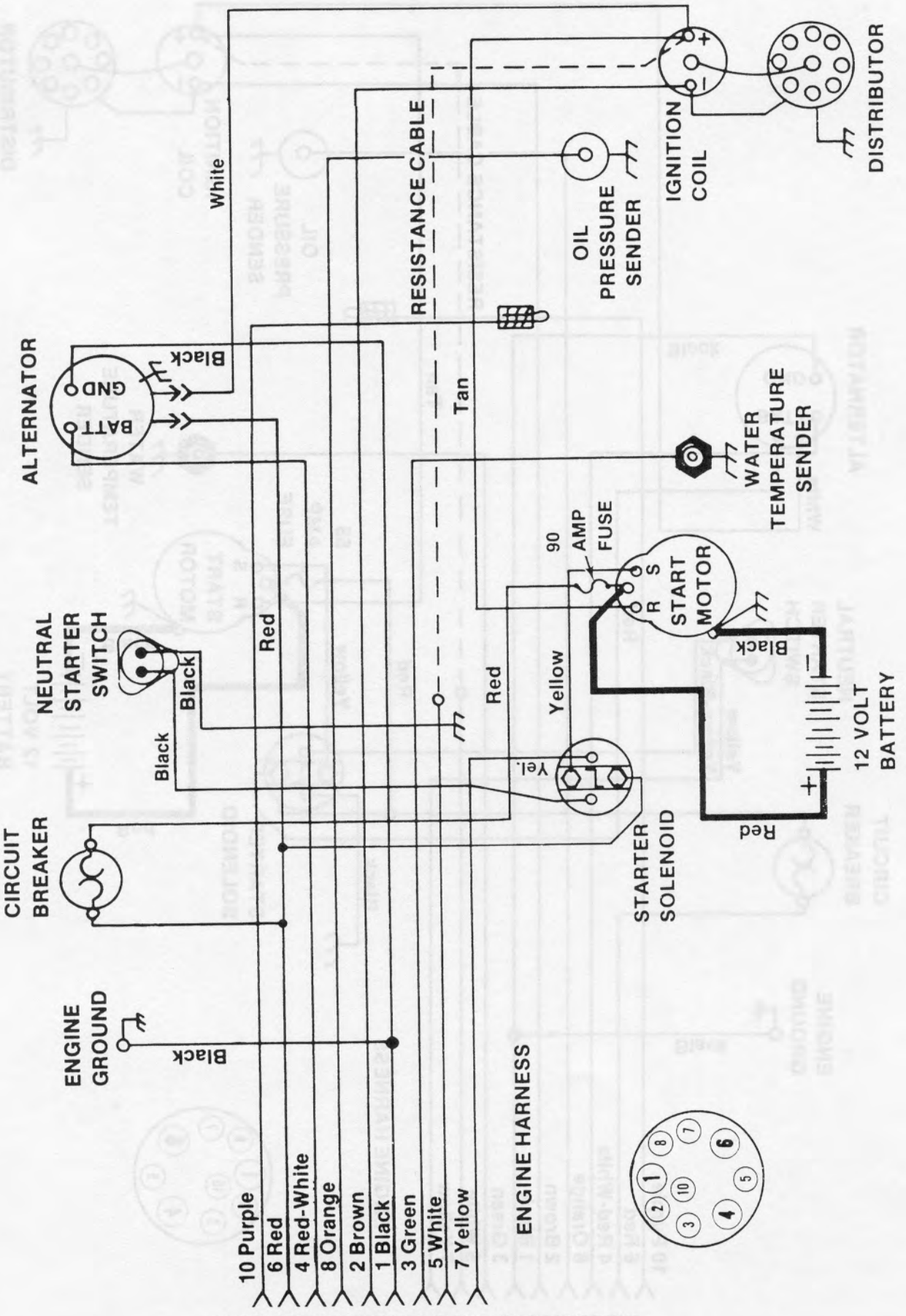


NOTE 1: Remove this wire if ammeter is to be used. Jumper must be left connected if Battery Meter is used.

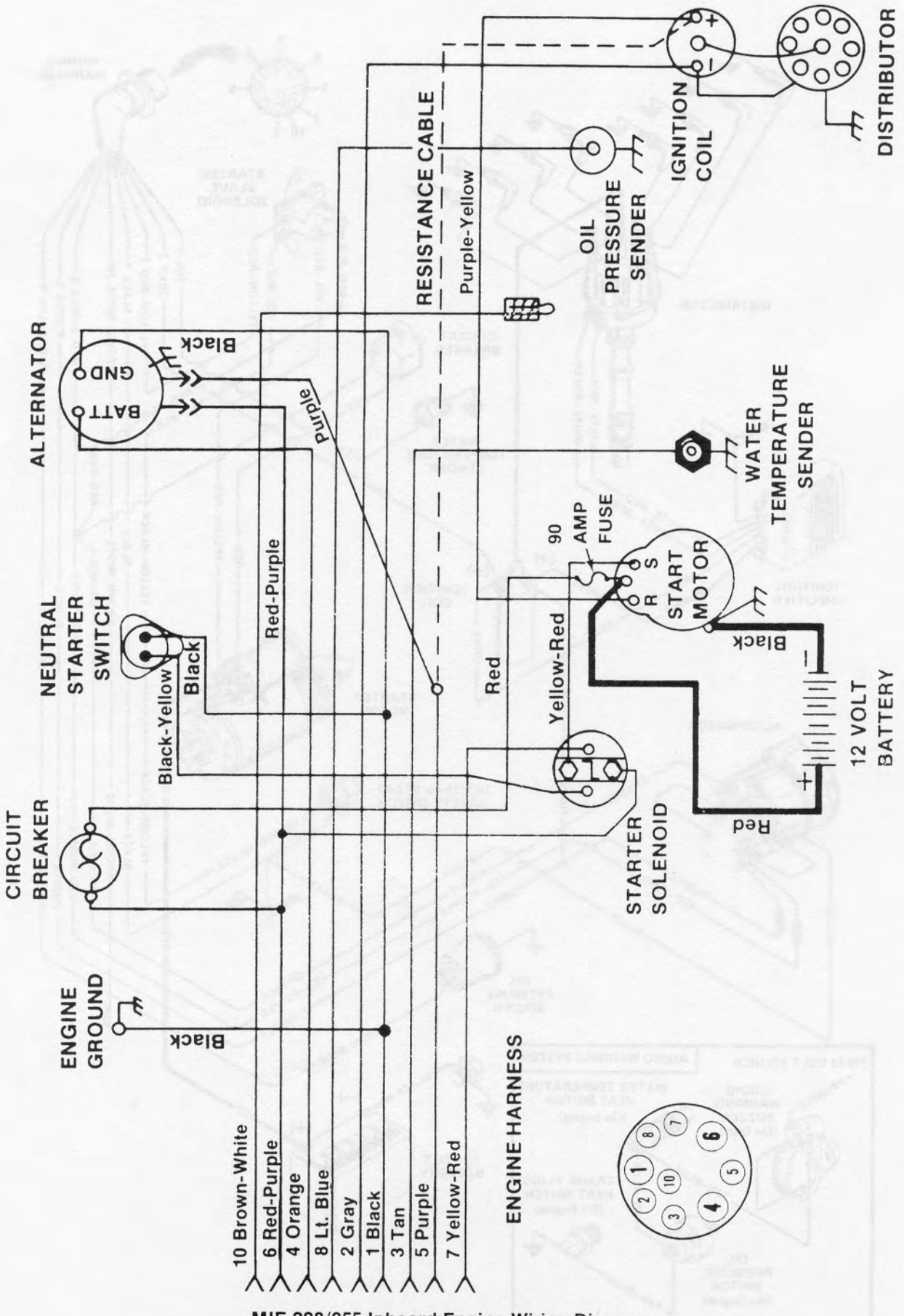
MIE 470 Inboard Engine Wiring Diagram
(Ammeter Circuit)



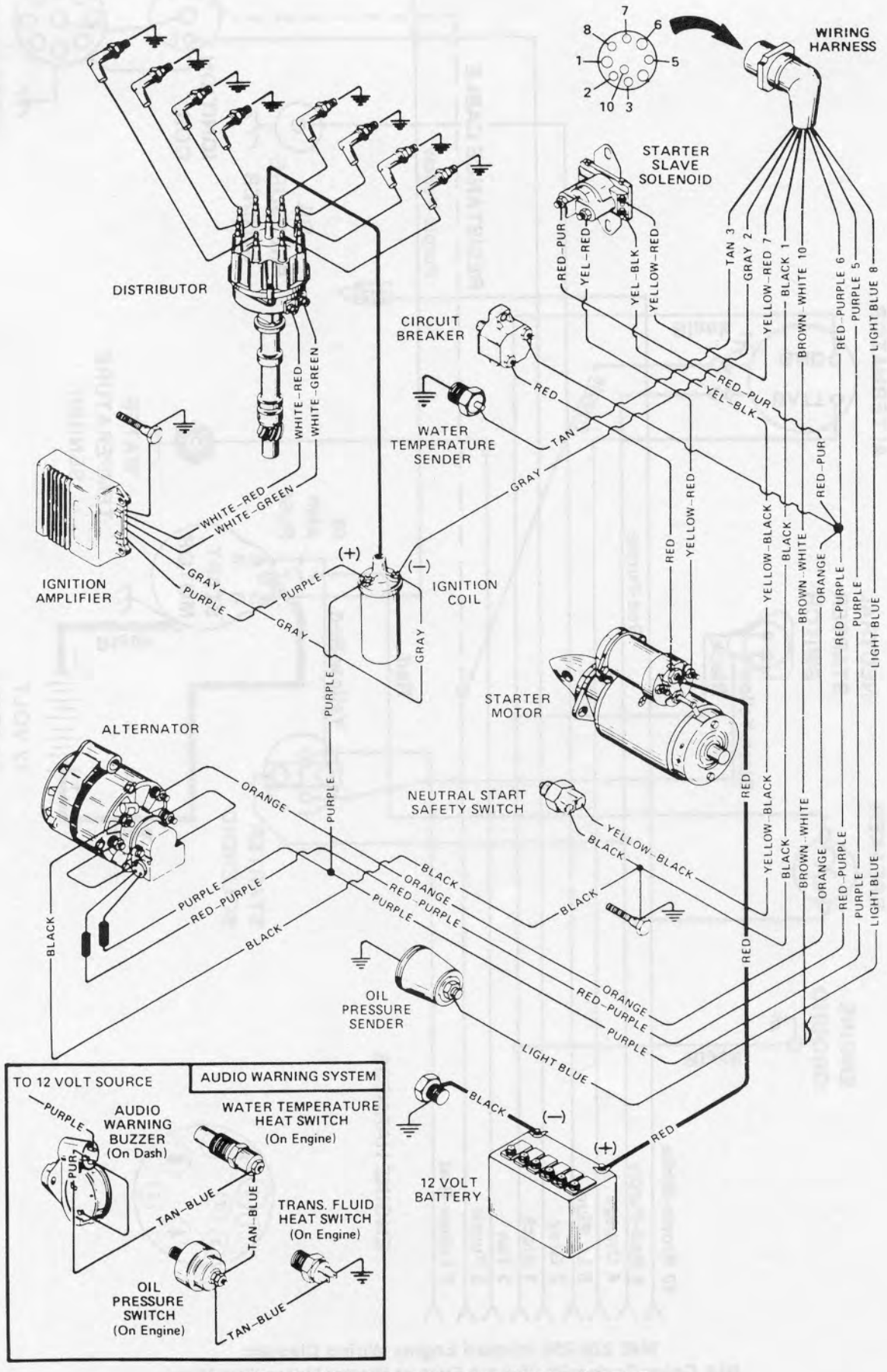
MIE 228/255 Inboard Engine Wiring Diagram
Pre BIA Color Code with 55 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



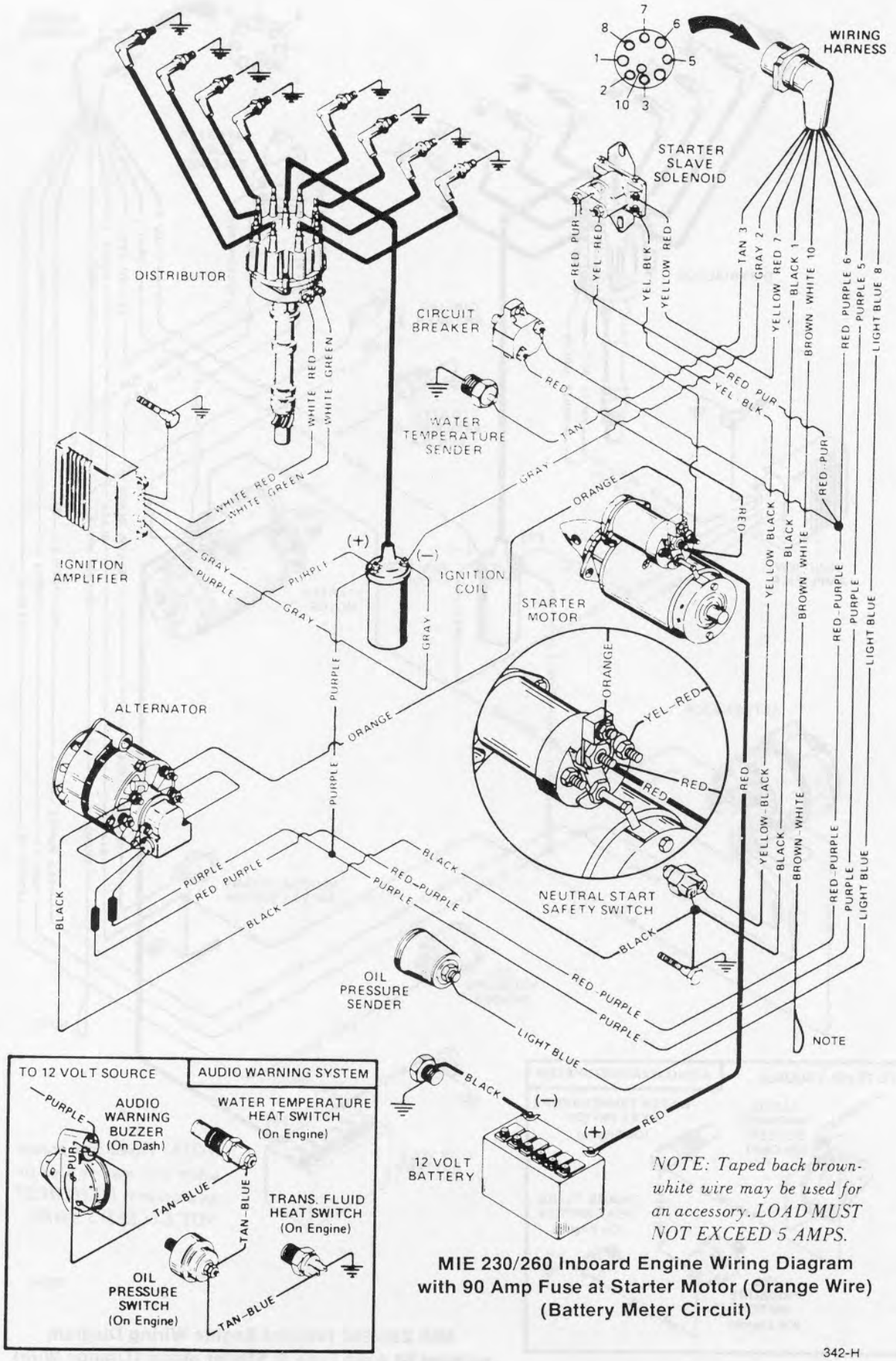
MCM 228/255 Inboard Engine Wiring Diagram
Pre BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



MIE 228/255 Inboard Engine Wiring Diagram
BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



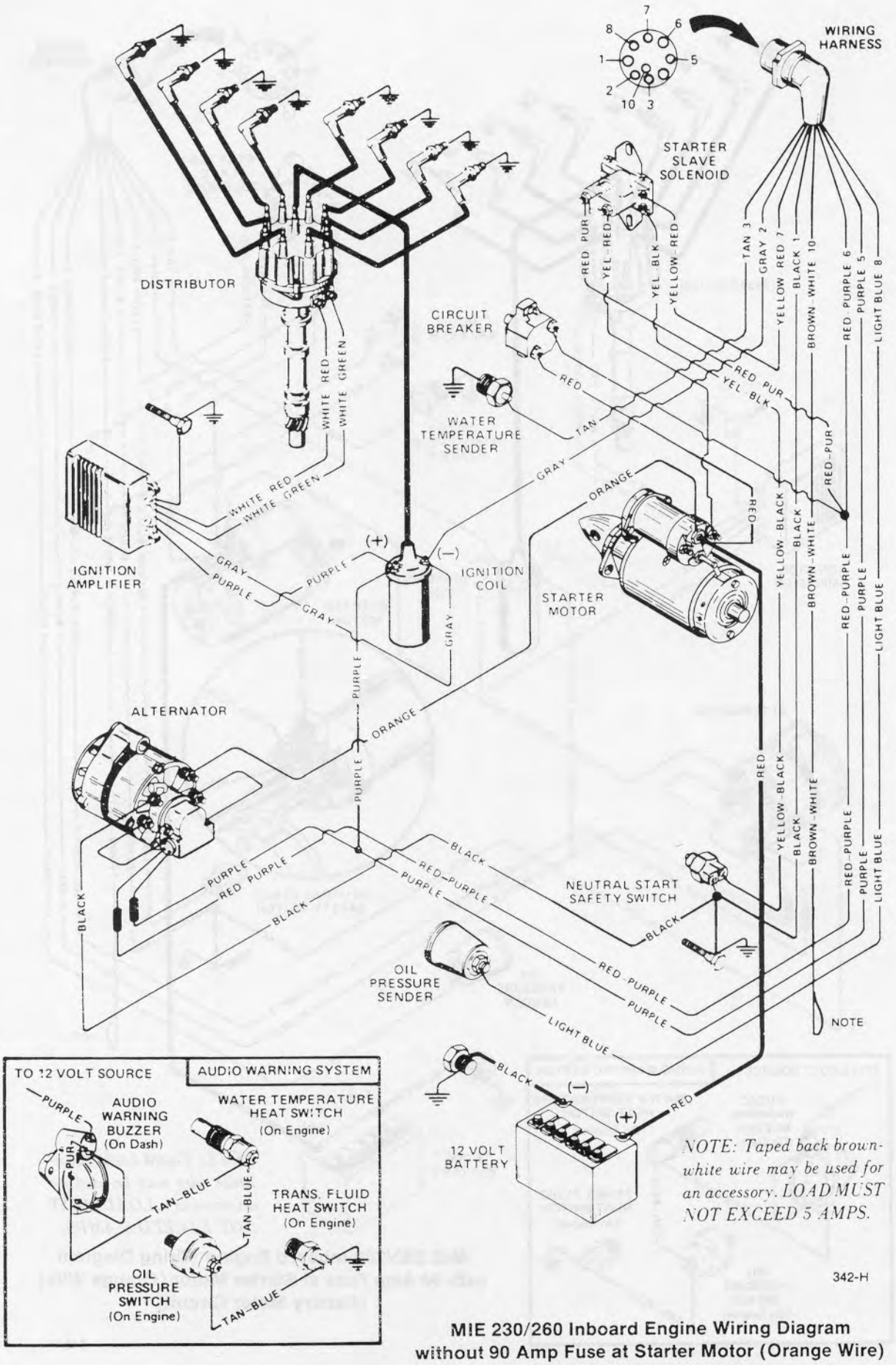
MIE 230/260 Inboard Engine Wiring Diagram
(Battery Meter Circuit)



NOTE: Taped back brown-white wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS.

MIE 230/260 Inboard Engine Wiring Diagram with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

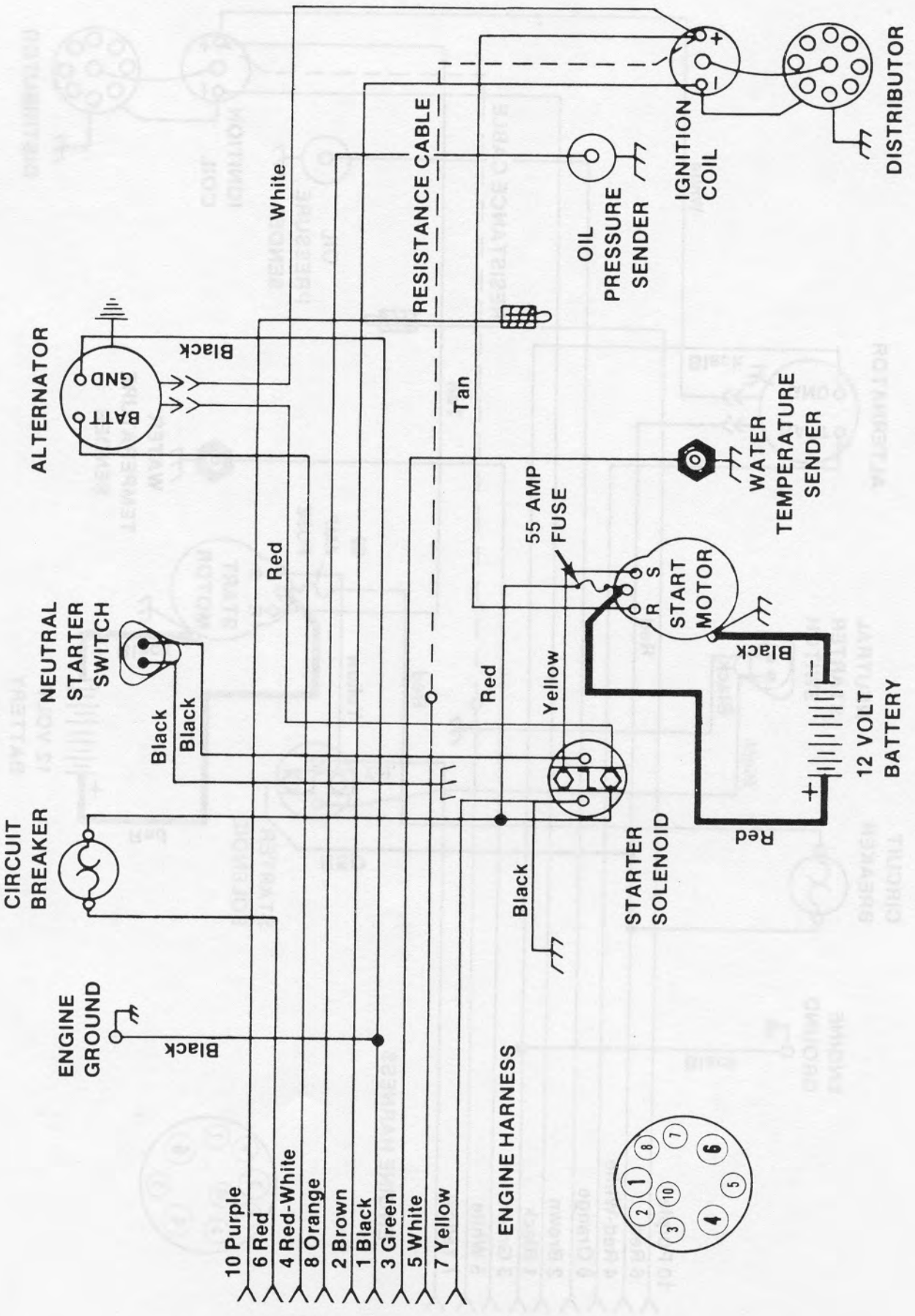
342-H



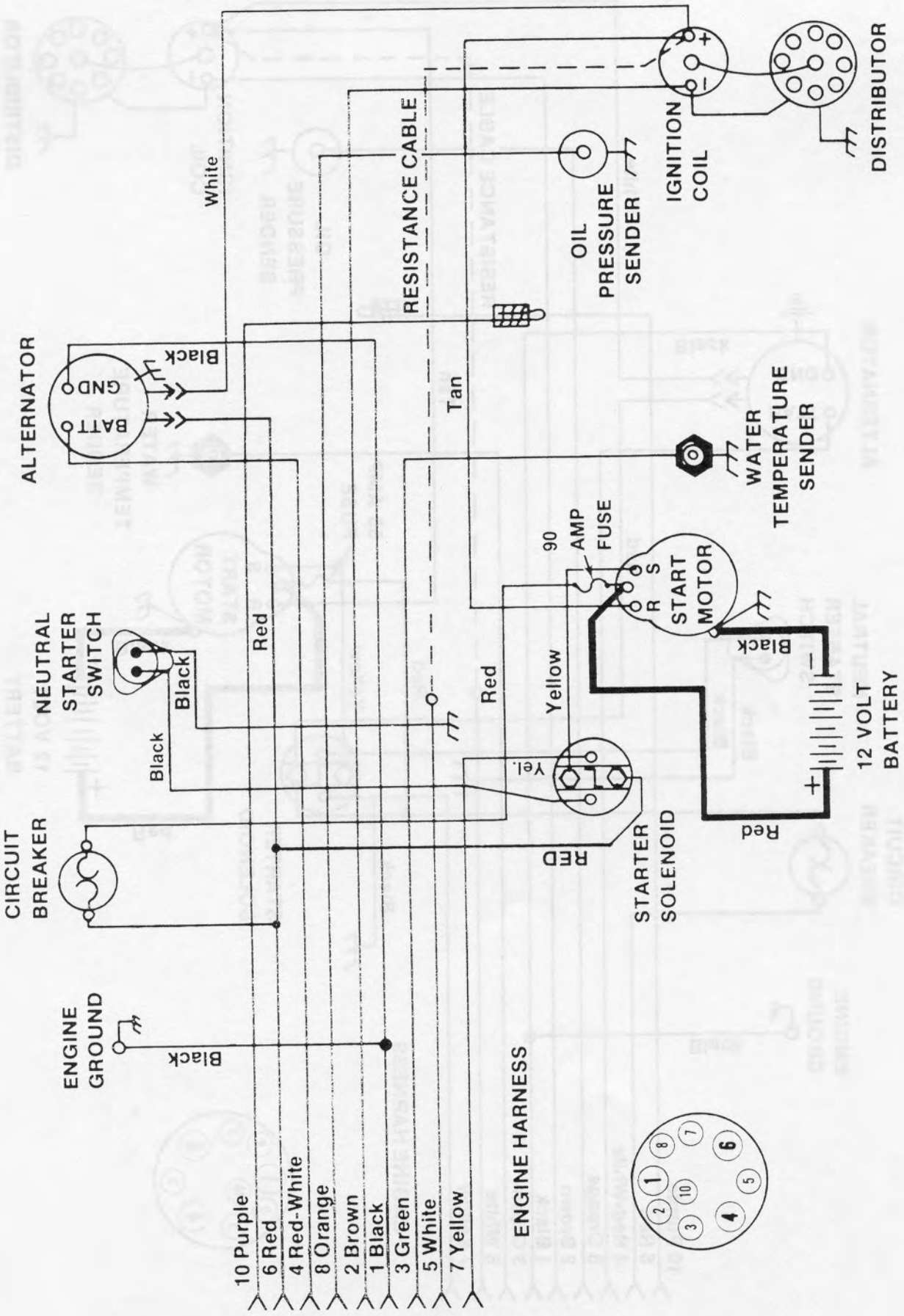
NOTE: Taped back brown-white wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS.

342-H

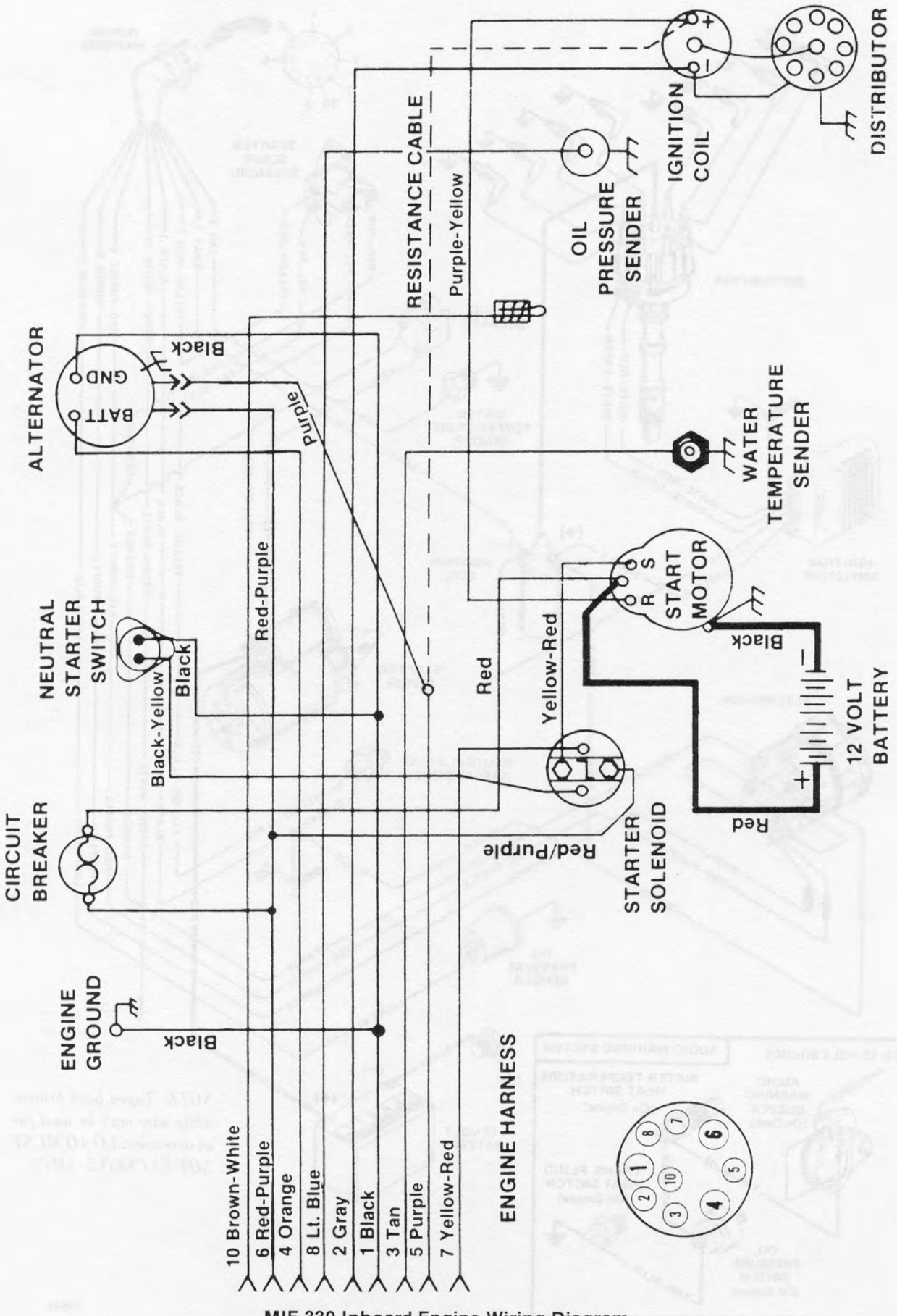
MIE 230/260 Inboard Engine Wiring Diagram without 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)



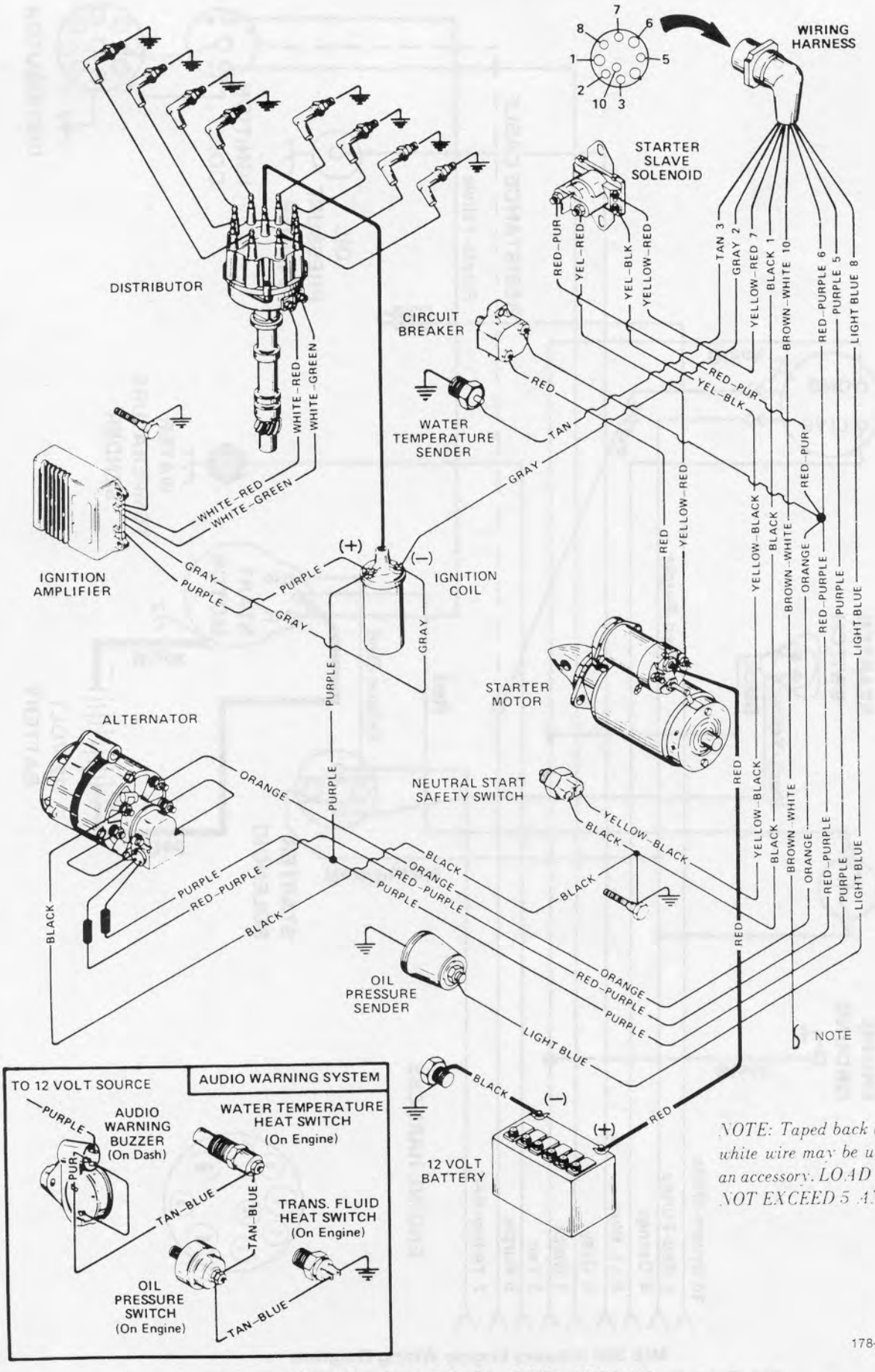
MIE 330 Inboard Engine Wiring Diagram
Pre BIA Color Code with 55 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



MIE 330 Inboard Engine Wiring Diagram
Pre BIA Color Code with 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



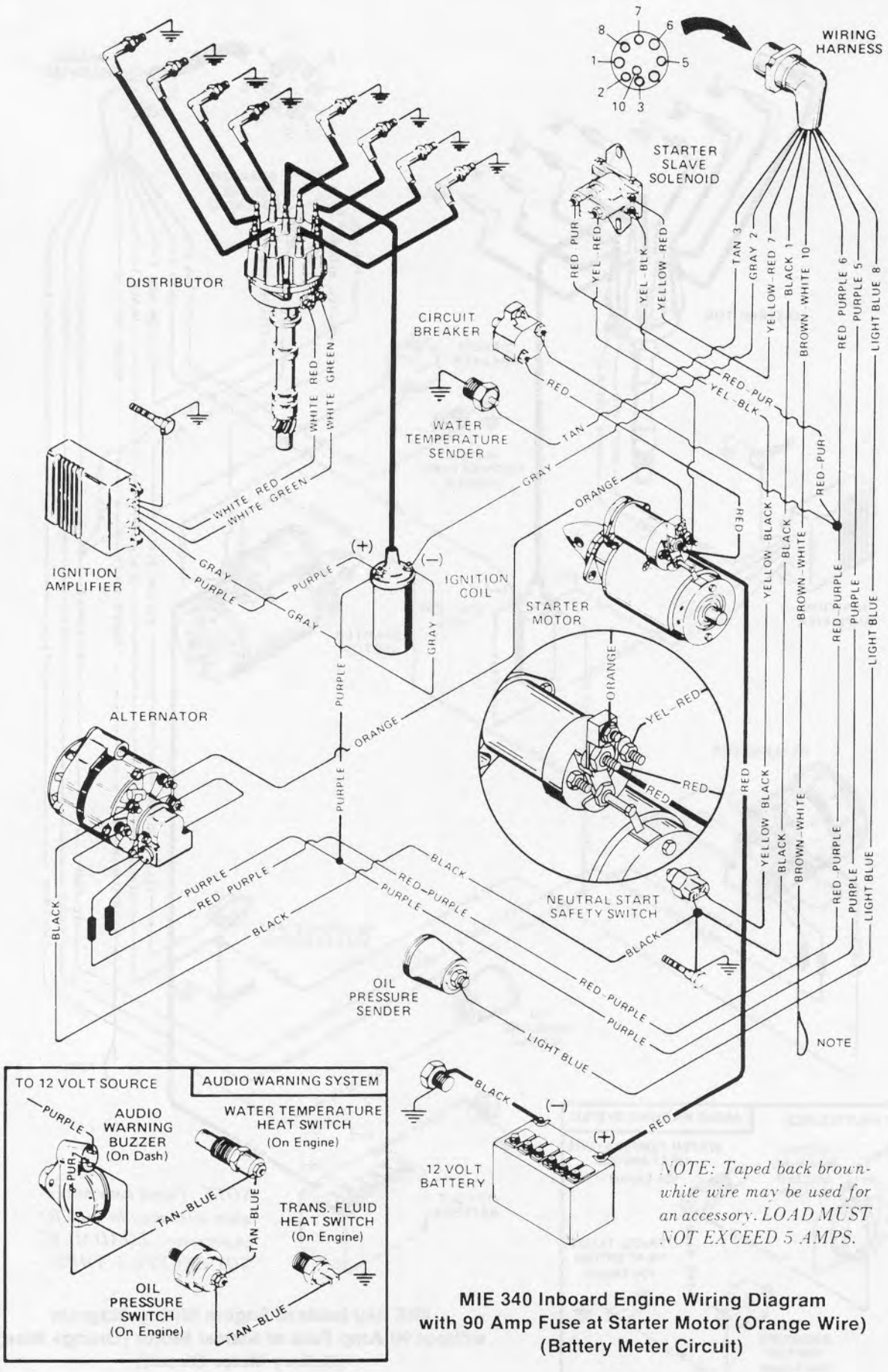
MIE 330 Inboard Engine Wiring Diagram
BIA Color Code without 90 Amp Fuse at Starter Motor (Red Wire)
(Ammeter Circuit)



NOTE: Taped back brown-white wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS.

178-H

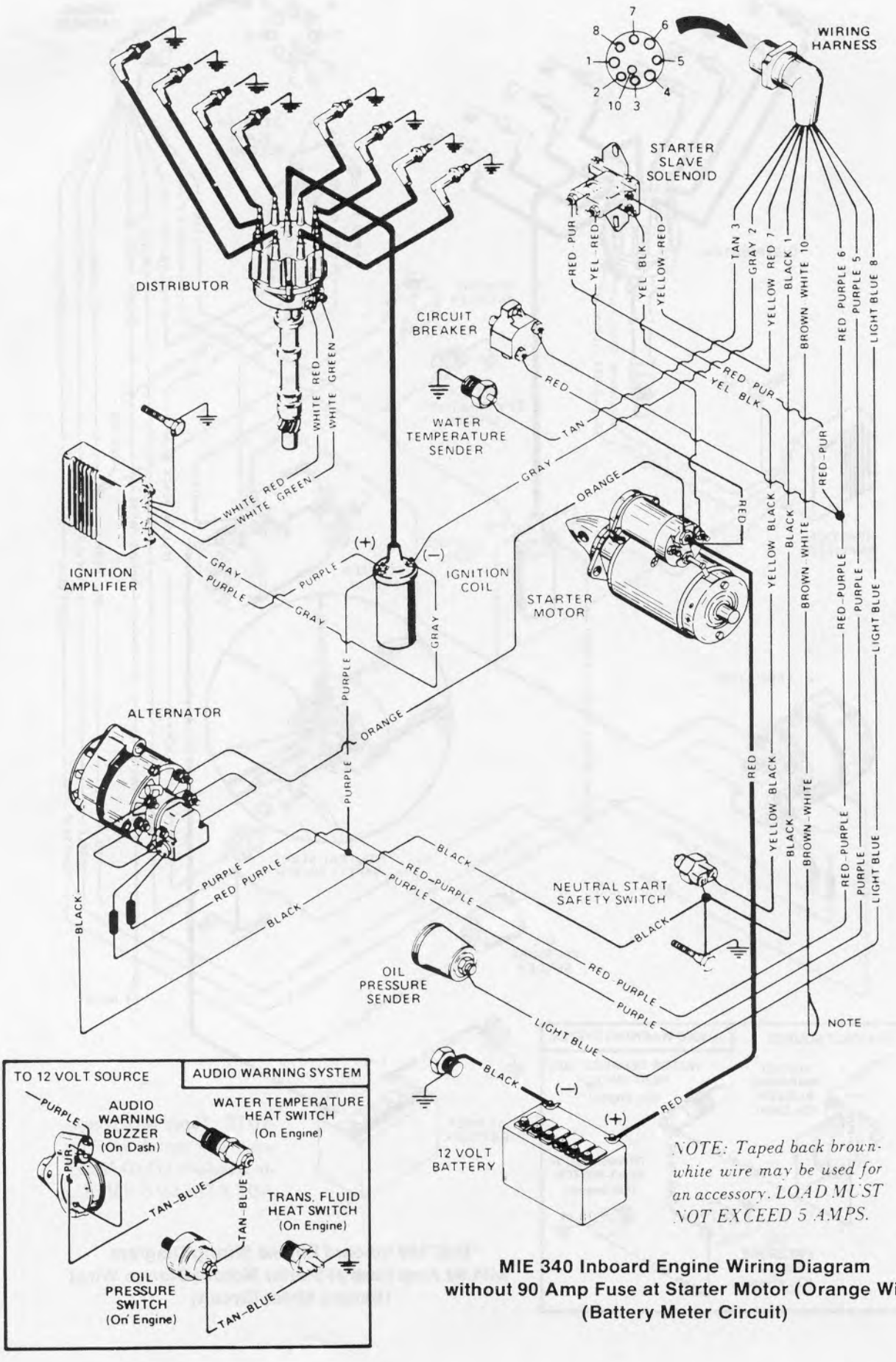
MIE 340 Inboard Engine Wiring Diagram
(Battery Meter Circuit)



NOTE: Taped back brown-white wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS.

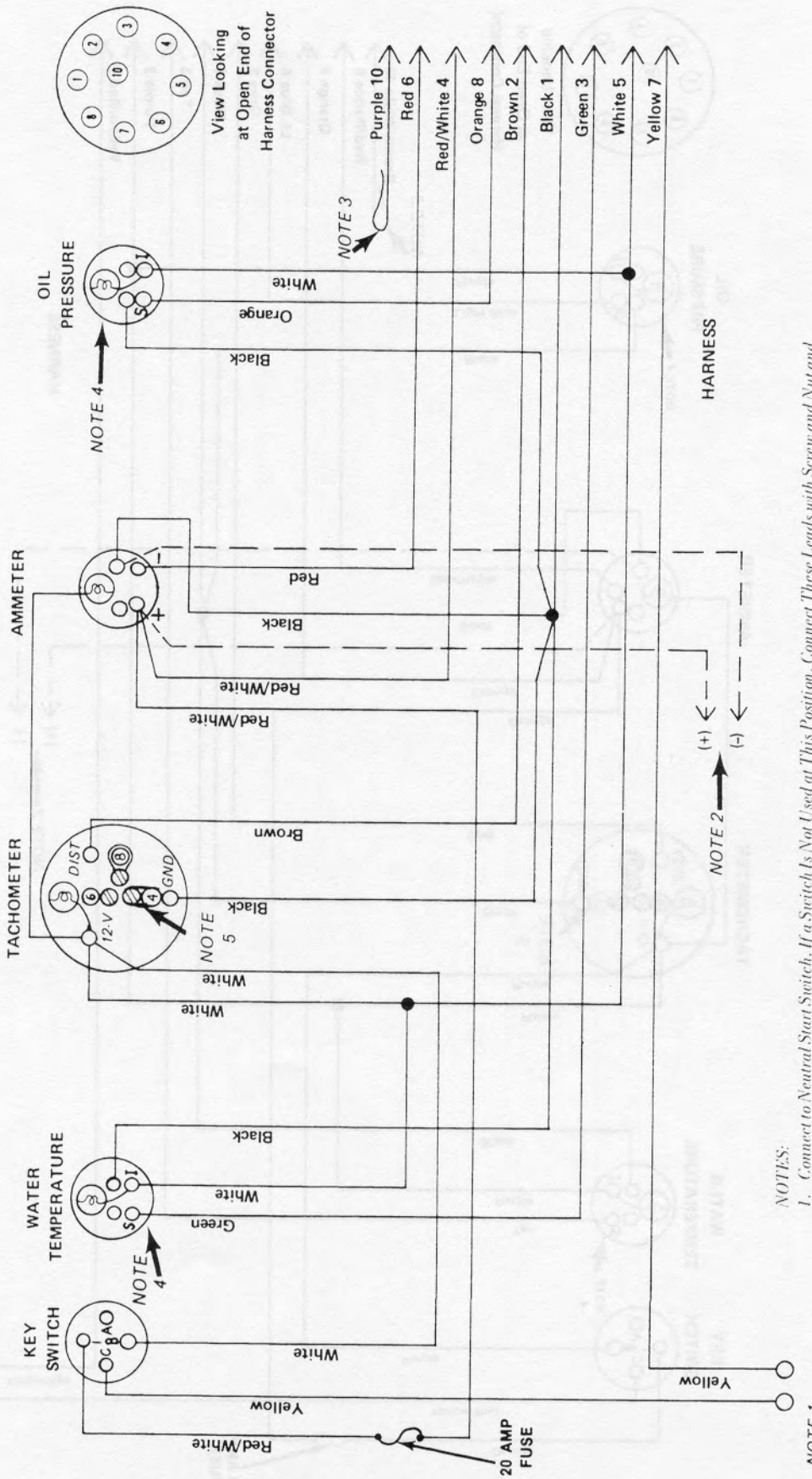
MIE 340 Inboard Engine Wiring Diagram with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

342-H



NOTE: Taped back brown-white wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS.

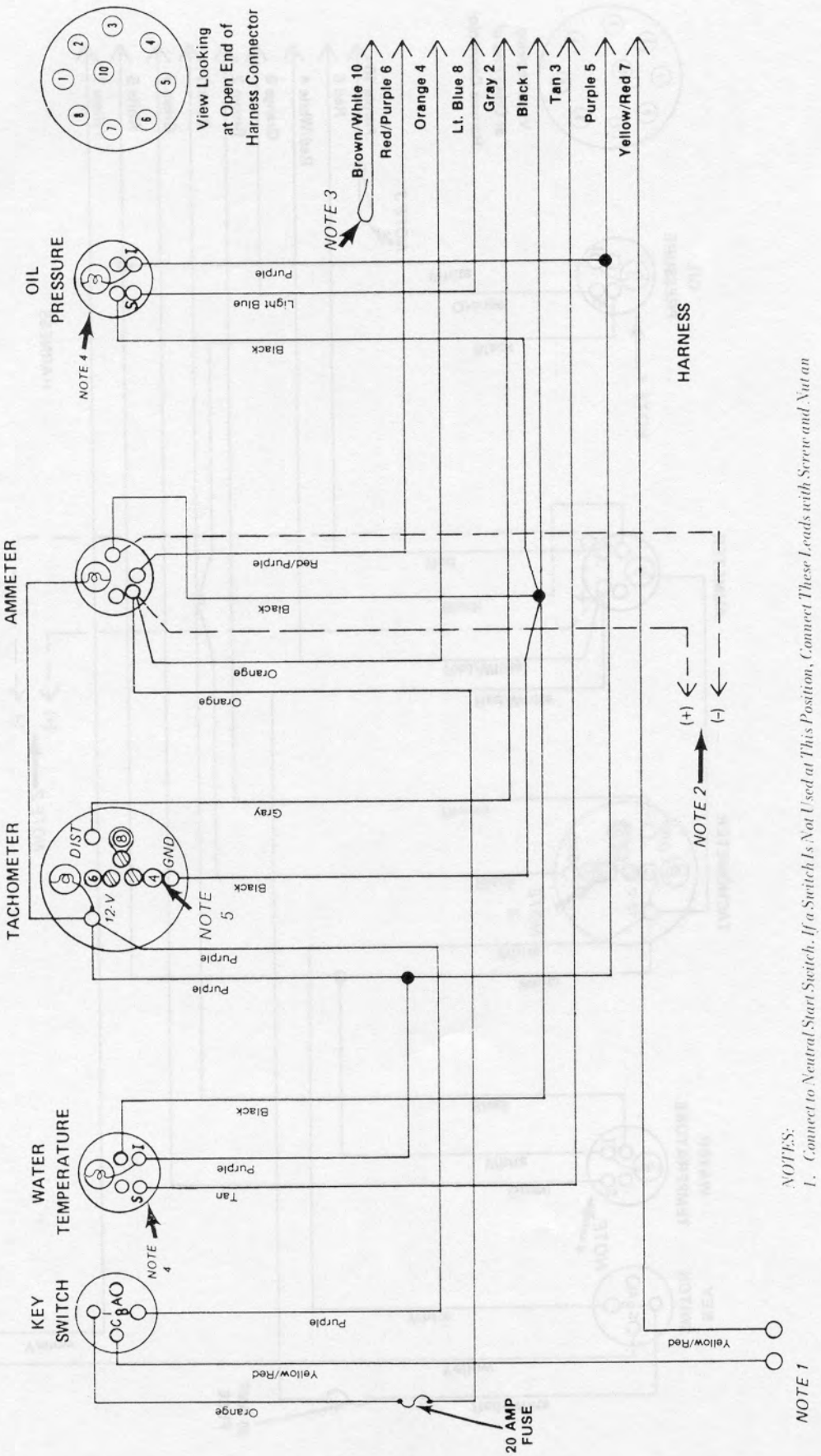
MIE 340 Inboard Engine Wiring Diagram without 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)



NOTES:

1. *Connect to Neutral Start Switch. If a Switch Is Not Used at This Position, Connect These Leads with Screw and Nut and Insulate with a Neoprene Sleeve.*
2. *An Accessory Fused Panel May Be Connected at This Point. Load May Not Exceed 35 Amps.*
3. *Purple Lead Is Taped Back at Instrument End and Engine End -- May Be Used for Accessories, Limit: 5 Amps.*
4. *S and I Terminal Position on Back of Gauges May Be in Different Locations. Each Gauge Has Its Own Markings.*
5. *4 = 4 Cyl.; 6 = 6 Cyl.; 8 = 8 Cyl.*
   1 = 4 Cyl.; 2 = 6 Cyl.; 3 = 8 Cyl.

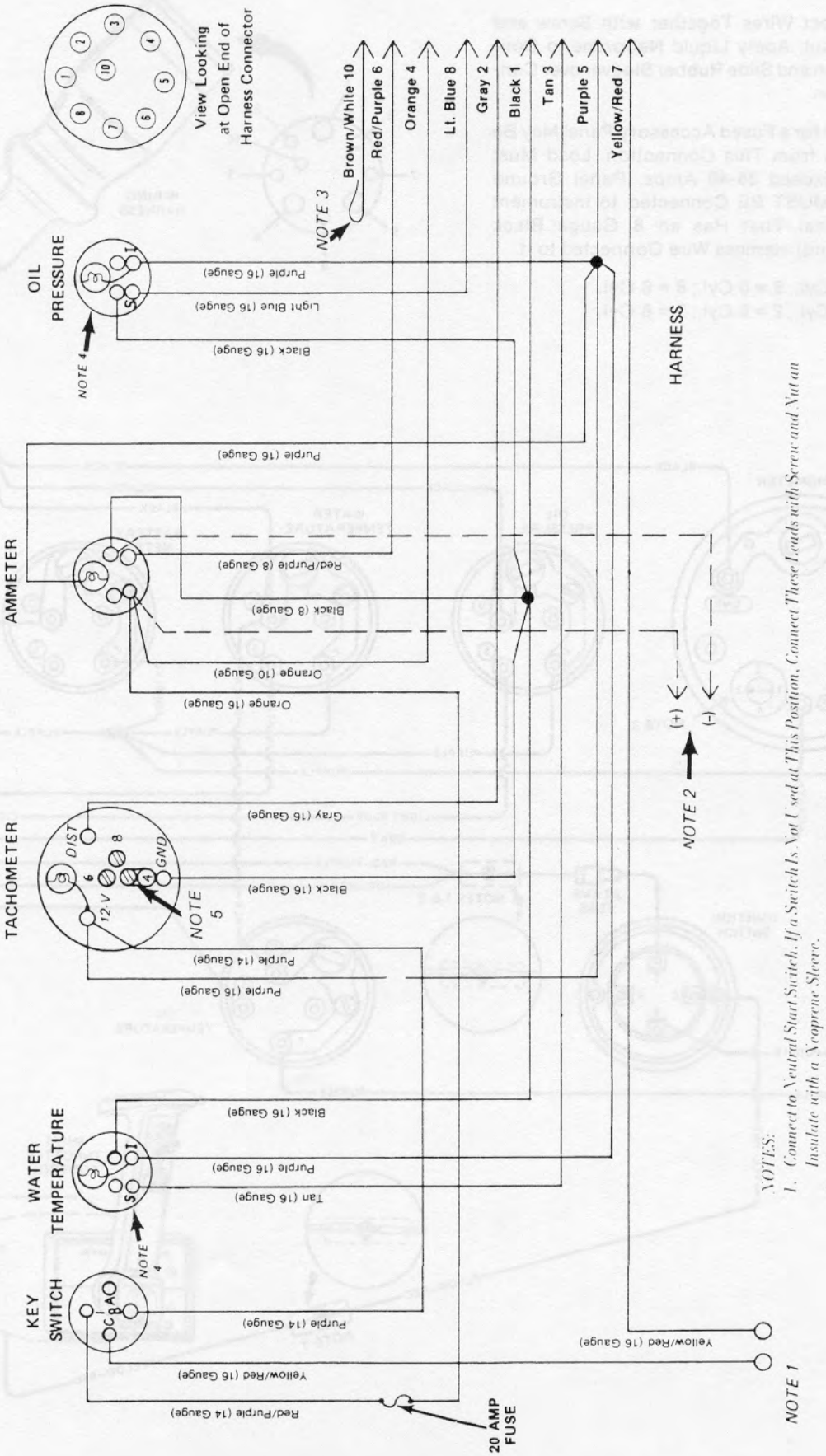
Instrument Wiring Diagram with Ammeter Circuit
Pre BIA Color Code



Instrument Wiring Diagram with Ammeter Circuit (Early Style)
BIA Color Code

NOTES:

1. *Connect to Neutral Start Switch. If a Switch Is Not Used at This Position, Connect These Leads with Screw and Nut an Insulate with a Neoprene Sleeve.*
2. *An Accessory Fused Panel May Be Connected at This Point. Load May Not Exceed 35 Amps.*
3. *Brown/White Lead Is Taped Back at Instrument End and Connected to Trim Sender Terminal Block at Engine End. T Be Used if a Power Trim Indicator Gauge (Optional) Is Installed.*
4. *S and I Terminal Position on Back of Gauges May Be in Different Locations. Each Gauge Has Its Own Markings*
5. *4 = 4 Cyl.; 6 = 6 Cyl.; 8 = 8 Cyl.*
   1 = 4 Cyl.; 2 = 6 Cyl.; 3 = 8 Cyl.



NOTES:

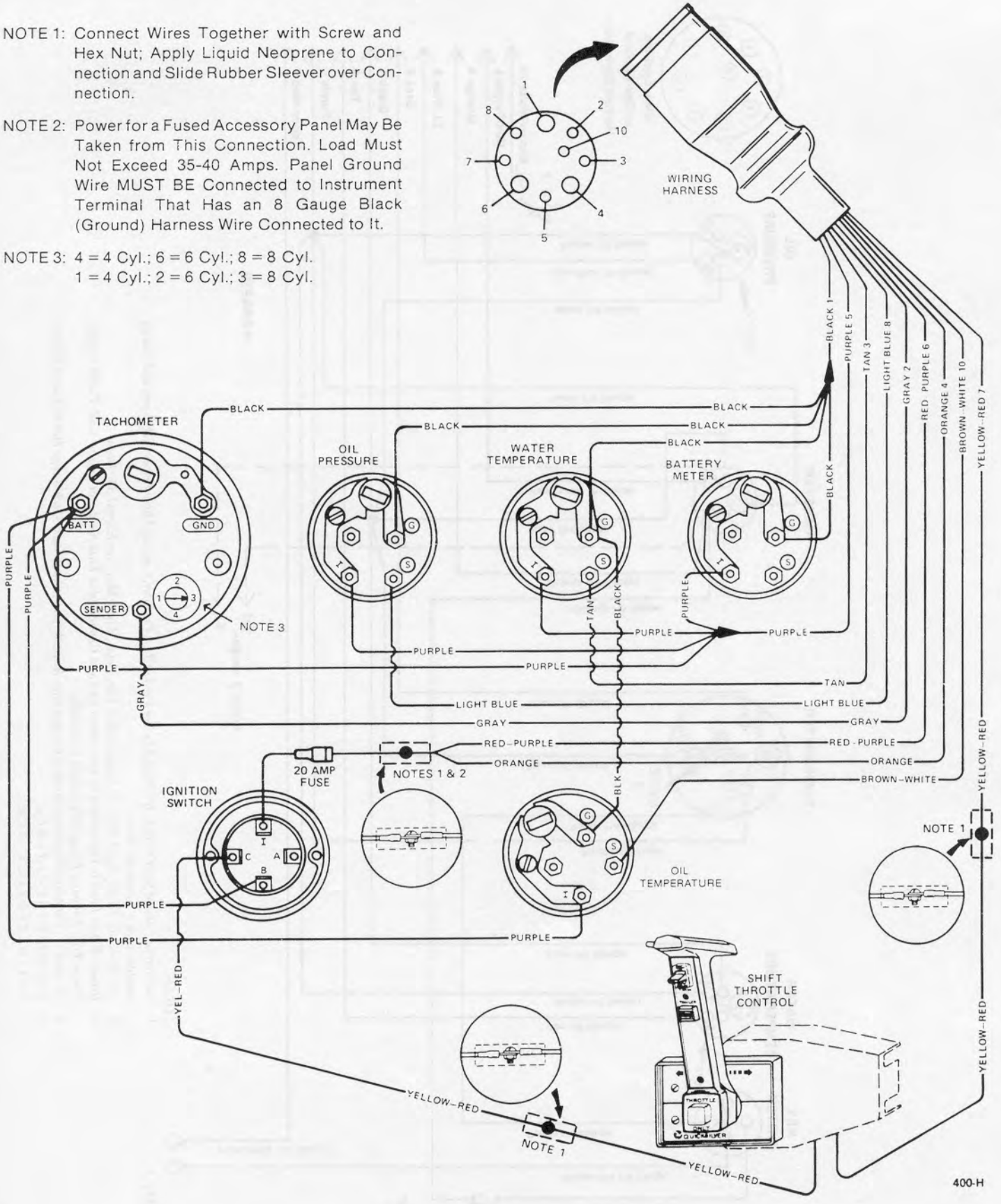
1. *Connect to Neutral Start Switch. If a Switch Is Not Used at This Position, Connect These Leads with Screw and Nut an Insulate with a Neoprene Sleeve.*
2. *An Accessory Fused Panel May Be Connected at This Point. Load May Not Exceed 35 Amps.*
3. *Brown/White Lead Is Taped Back at Instrument End and Connected to Trim Sender at Engine End. To Be Used if Power Trim Indicator Gauge (Optional) Is Installed.*
4. *S and 1 Terminal Position on Back of Gauges May Be in Different Locations. Each Gauge Has Its Own Markings*
5. *1 = 4 Cyl.; 6 = 6 Cyl.; 8 = 8 Cyl.*
   1 = 4 Cyl.; 2 = 6 Cyl.; 3 = 8 Cyl.

Instrument Wiring Diagram with Ammeter Circuit (Later Style)
BIA Color Code

NOTE 1: Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Sleever over Connection.

NOTE 2: Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 35-40 Amps. Panel Ground Wire MUST BE Connected to Instrument Terminal That Has an 8 Gauge Black (Ground) Harness Wire Connected to It.

NOTE 3: 4 = 4 Cyl.; 6 = 6 Cyl.; 8 = 8 Cyl.
1 = 4 Cyl.; 2 = 6 Cyl.; 3 = 8 Cyl.

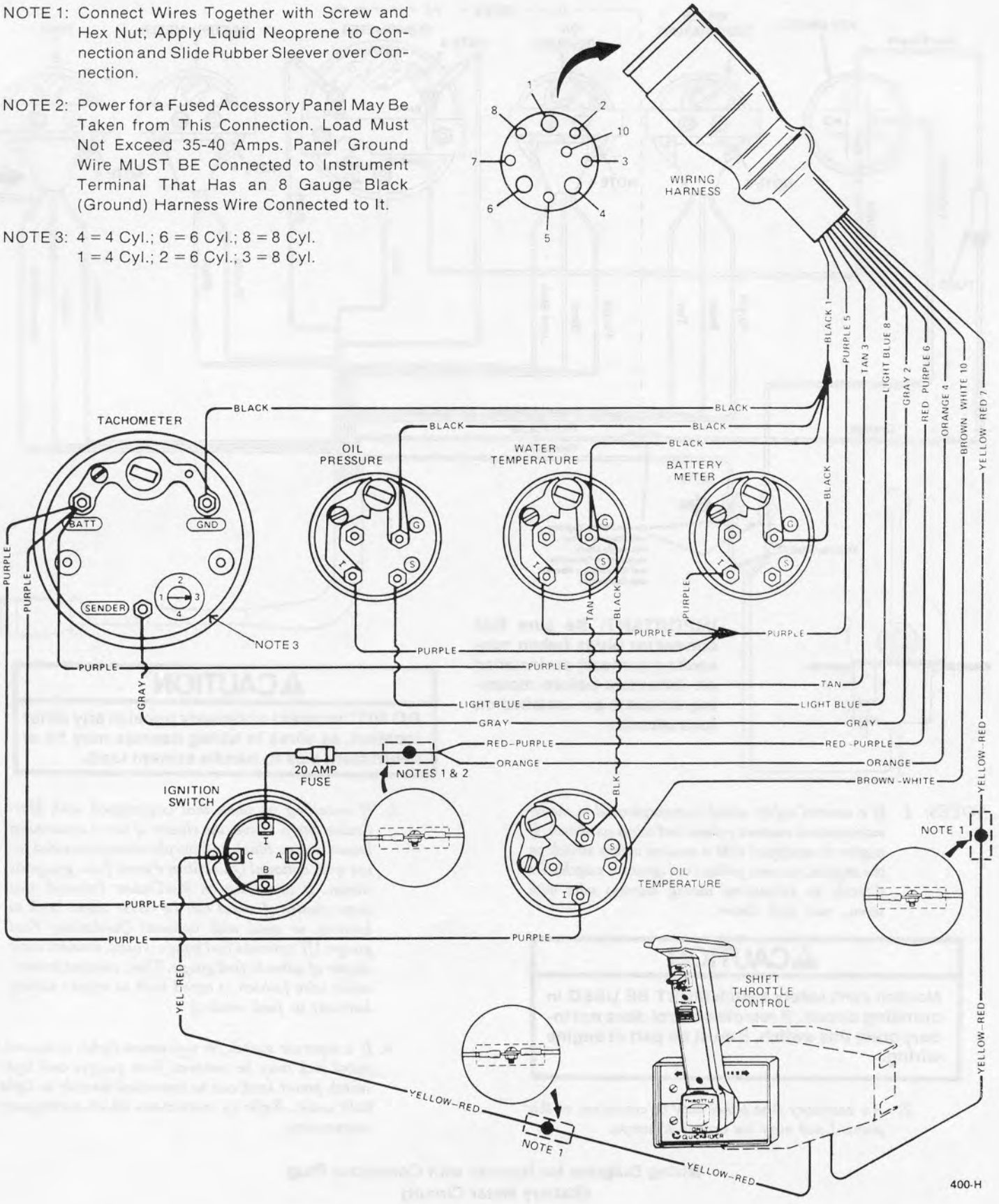


Instrumentation Wiring Diagram with Battery Meter Circuit

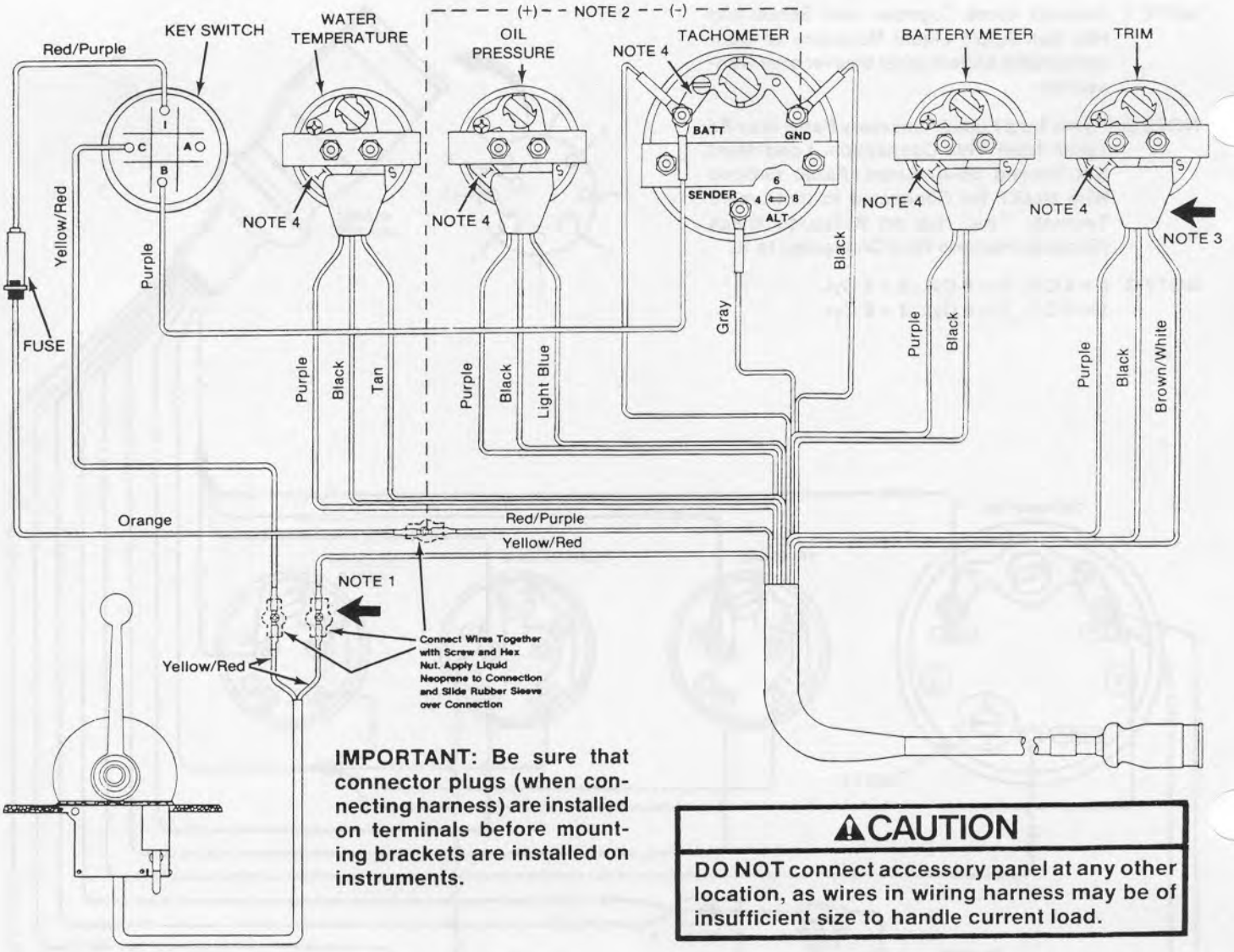
NOTE 1: Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Sleever over Connection.

NOTE 2: Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 35-40 Amps. Panel Ground Wire MUST BE Connected to Instrument Terminal That Has an 8 Gauge Black (Ground) Harness Wire Connected to It.

NOTE 3: 4 = 4 Cyl.; 6 = 6 Cyl.; 8 = 8 Cyl.
1 = 4 Cyl.; 2 = 6 Cyl.; 3 = 8 Cyl.



MCM 370/400TRS Instrument Wiring Diagram (Typical Gauges Shown)



IMPORTANT: Be sure that connector plugs (when connecting harness) are installed on terminals before mounting brackets are installed on instruments.

⚠CAUTION

DO NOT connect accessory panel at any other location, as wires in wiring harness may be of insufficient size to handle current load.

NOTES: 1. *If a neutral safety switch is incorporated in the remote control connect yellow/red wires as shown. If engine is equipped with a neutral safety switch on the engine, connect yellow/red ignition switch wire directly to yellow/red wiring harness wire with screw, nut and sleeve.*

⚠CAUTION

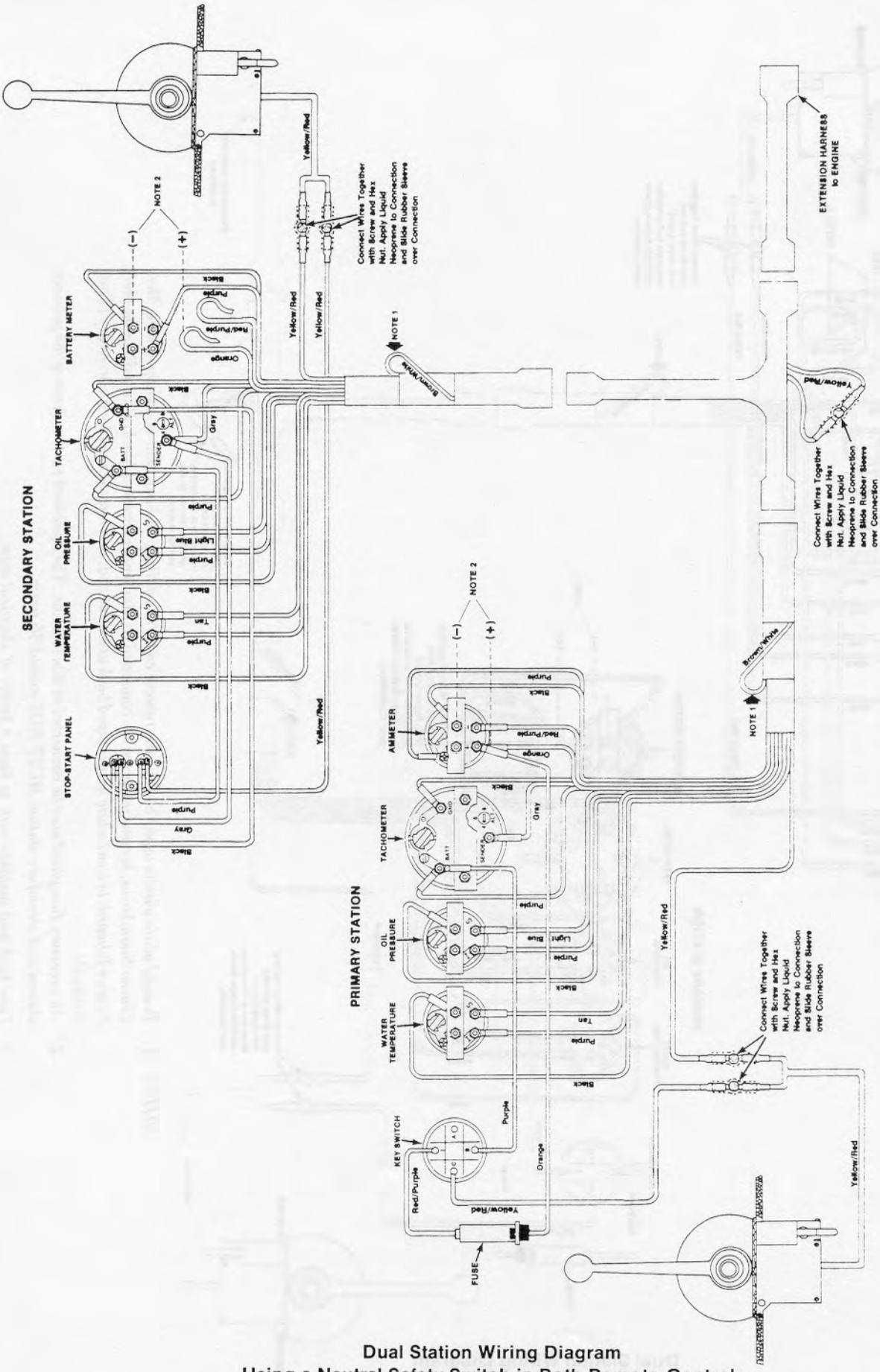
Neutral start safety switch MUST BE USED in cranking circuit. If remote control does not incorporate this switch, it must be part of engine wiring.

2. *An accessory fuse panel may be connected at this point. Load may not exceed 35 amps.*

3. *If installing on boat, that is equipped with MerCruiser Stern Drive, the cluster of wires containing brown/white, black and purple wires is intended for use with optional Quicksilver Power Trim gauge as shown. If installing on MerCruiser Inboard, this same cluster of wires can be either taped back to harness, or used with optional Quicksilver Fuel gauge. [If optional fuel gauge is used, connect same cluster of wires to fuel gauge. Then, connect brown/white wire (which is taped back to engine wiring harness) to fuel sender.]*

4. *If a separate switch for instrument lights is desired, metal link may be removed from gauges and light switch power lead can be connected directly to light bulb socket. Refer to instructions which accompany instruments.*

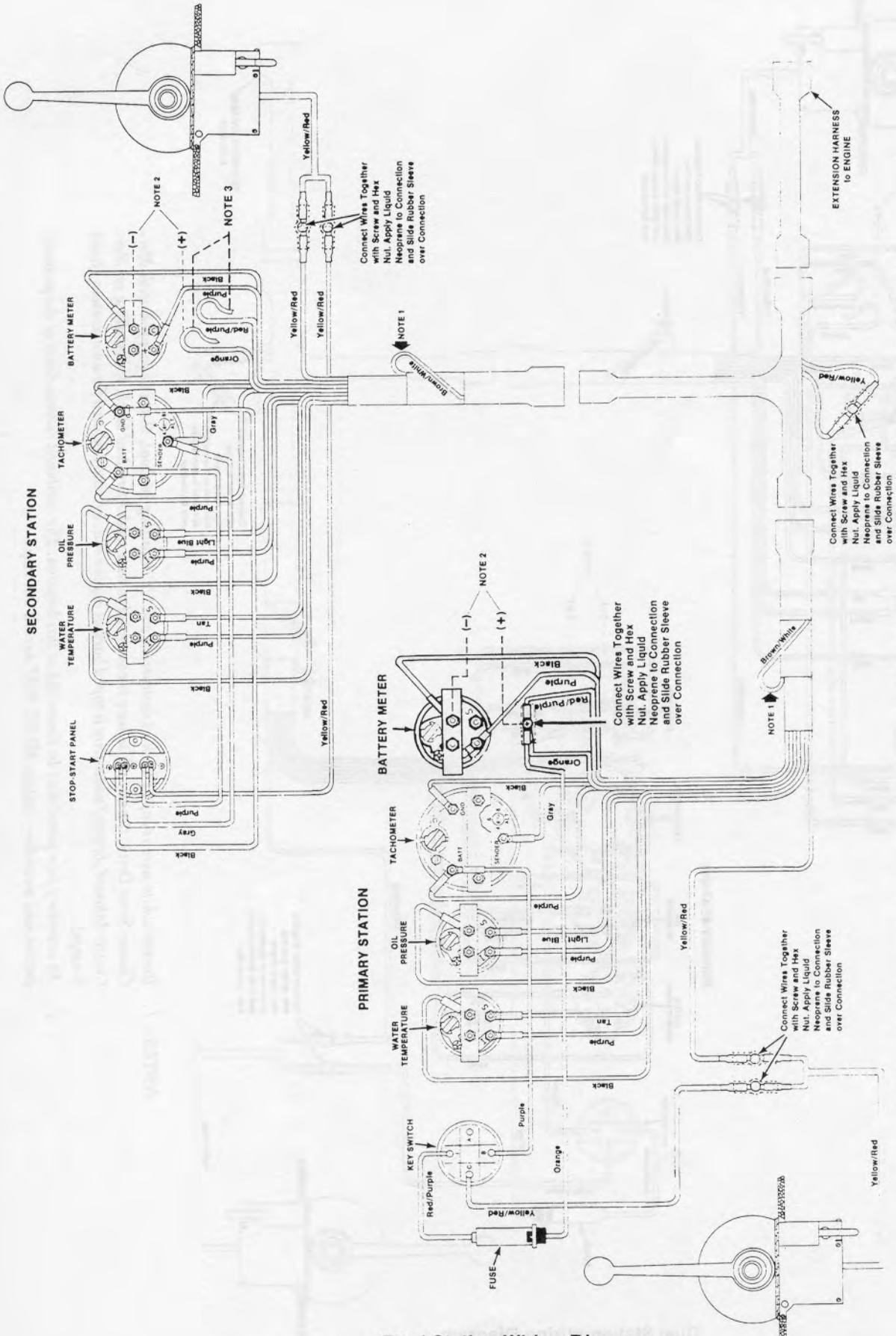
Wiring Diagram for Harness with Connector Plug (Battery Meter Circuit)



Dual Station Wiring Diagram
Using a Neutral Safety Switch in Both Remote Controls
(Ammeter Circuit)

NOTES:

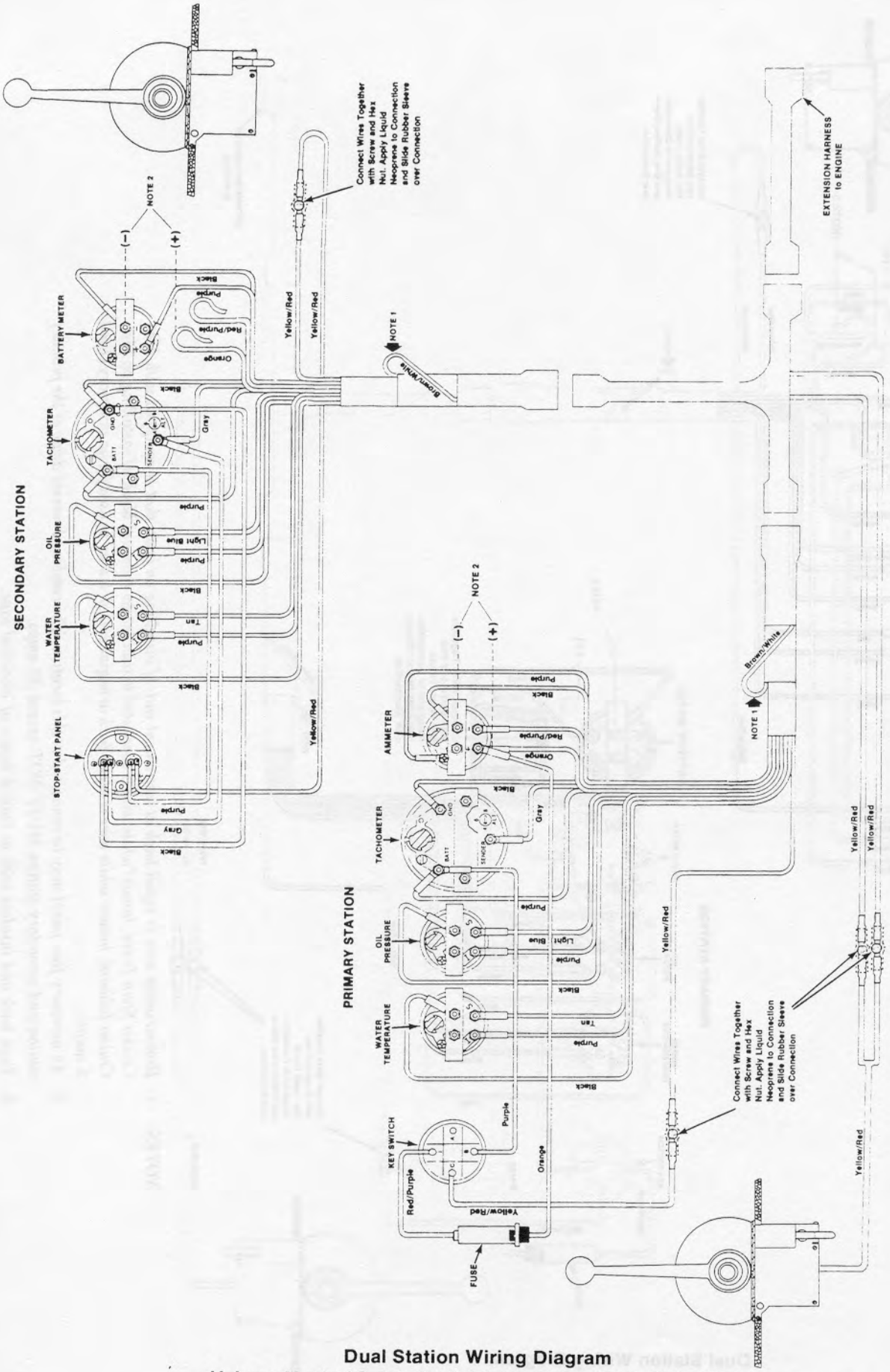
1. *Brown/ white wire is taped back at instrument end. If installing on boat, that is equipped with Mer-Cruiser Stern Drive, brown/ white wire is connected to trim sender terminal block. If installing on Mer-Cruiser Inboard, brown/ white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*



Dual Station Wiring Diagram
Using a Neutral Safety Switch in Both Remote Controls
(Battery Meter Circuit)

NOTES:

1. *Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with Mer-Cruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on Mer-Cruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*
3. *Tape back and insulate with at least 4 layers of electrical tape.*

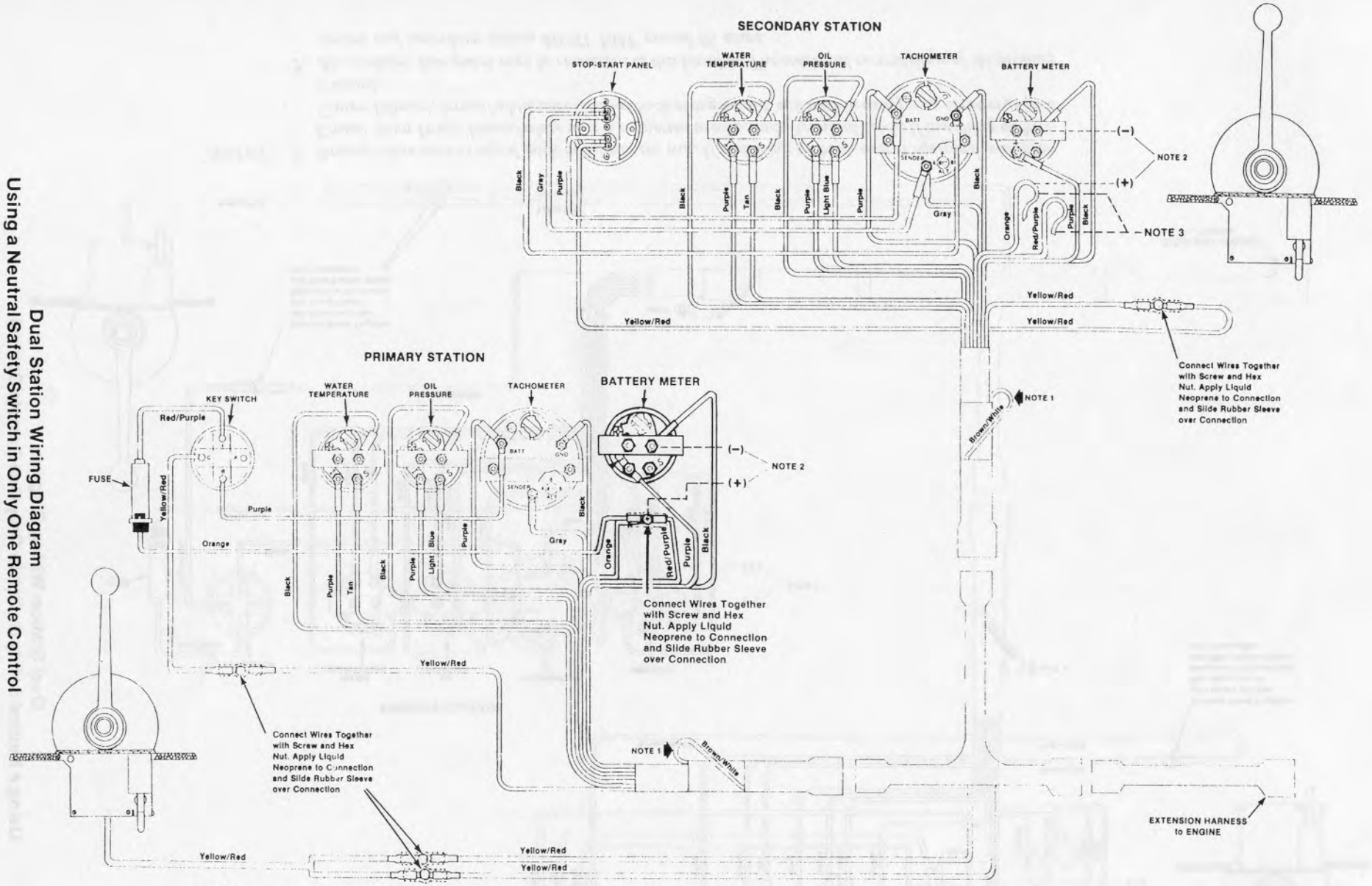


Dual Station Wiring Diagram
Using a Neutral Safety Switch in Only One Remote Control
(Ammeter Circuit)

NOTES:

1. *Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with Mercruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on Mercruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*

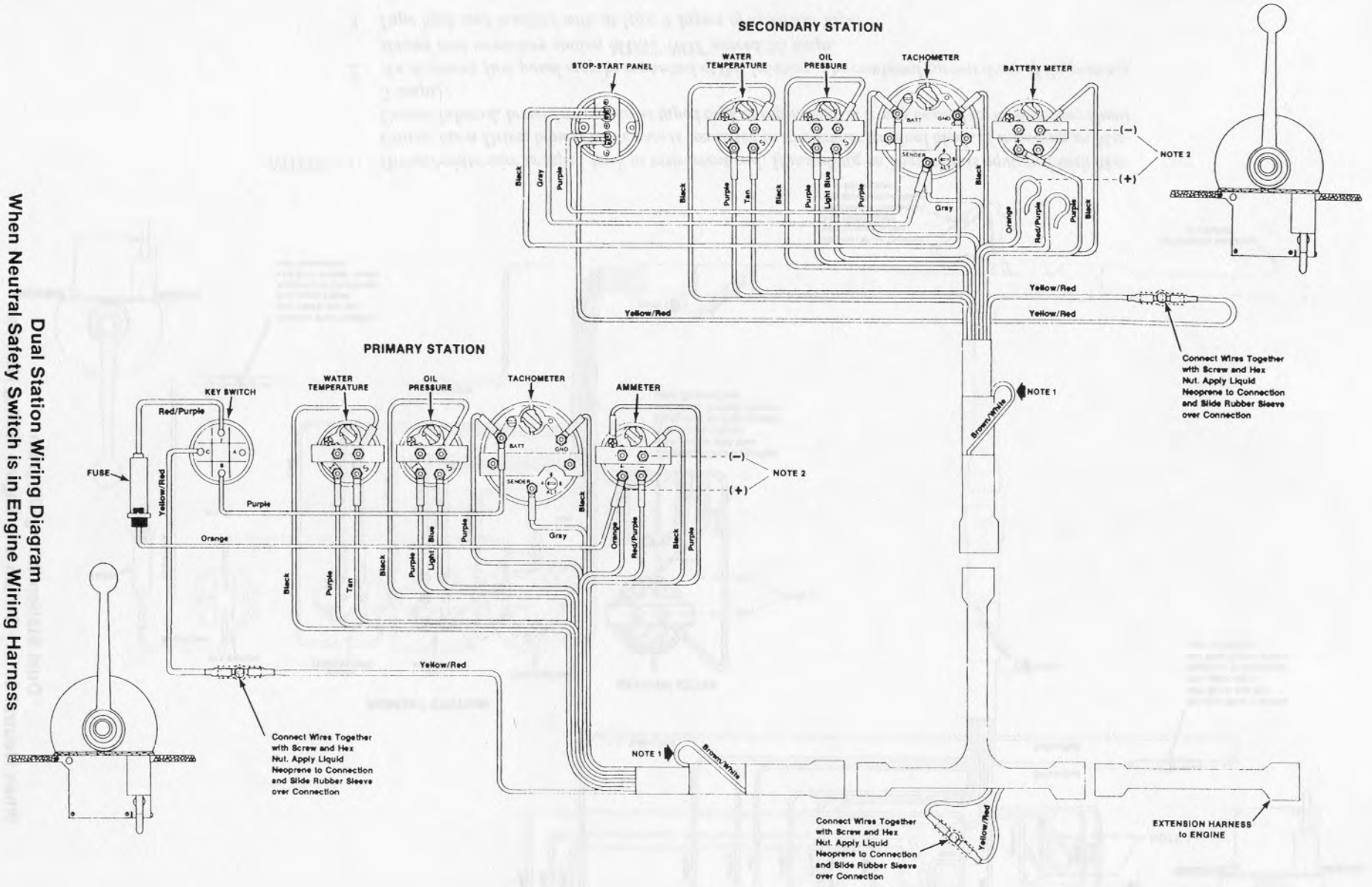
Dual Station Wiring Diagram
Using a Neutral Safety Switch in Only One Remote Control
(Battery Meter Circuit)



NOTES:

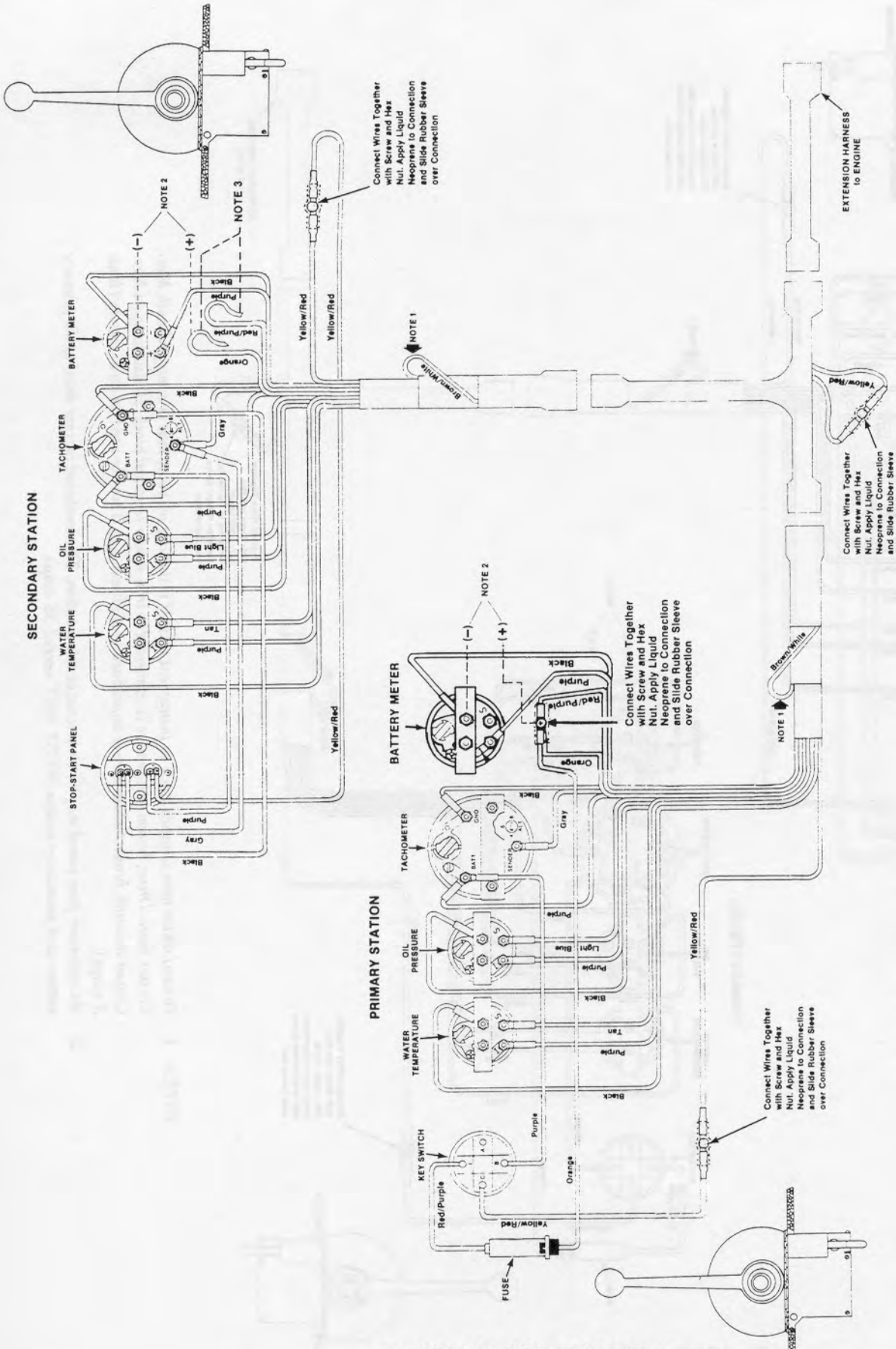
1. *Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*
3. *Tape back and insulate with at least 4 layers of electrical tape.*

Dual Station Wiring Diagram
When Neutral Safety Switch is in Engine Wiring Harness (Ammeter Circuit)



NOTES: 1. *Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*

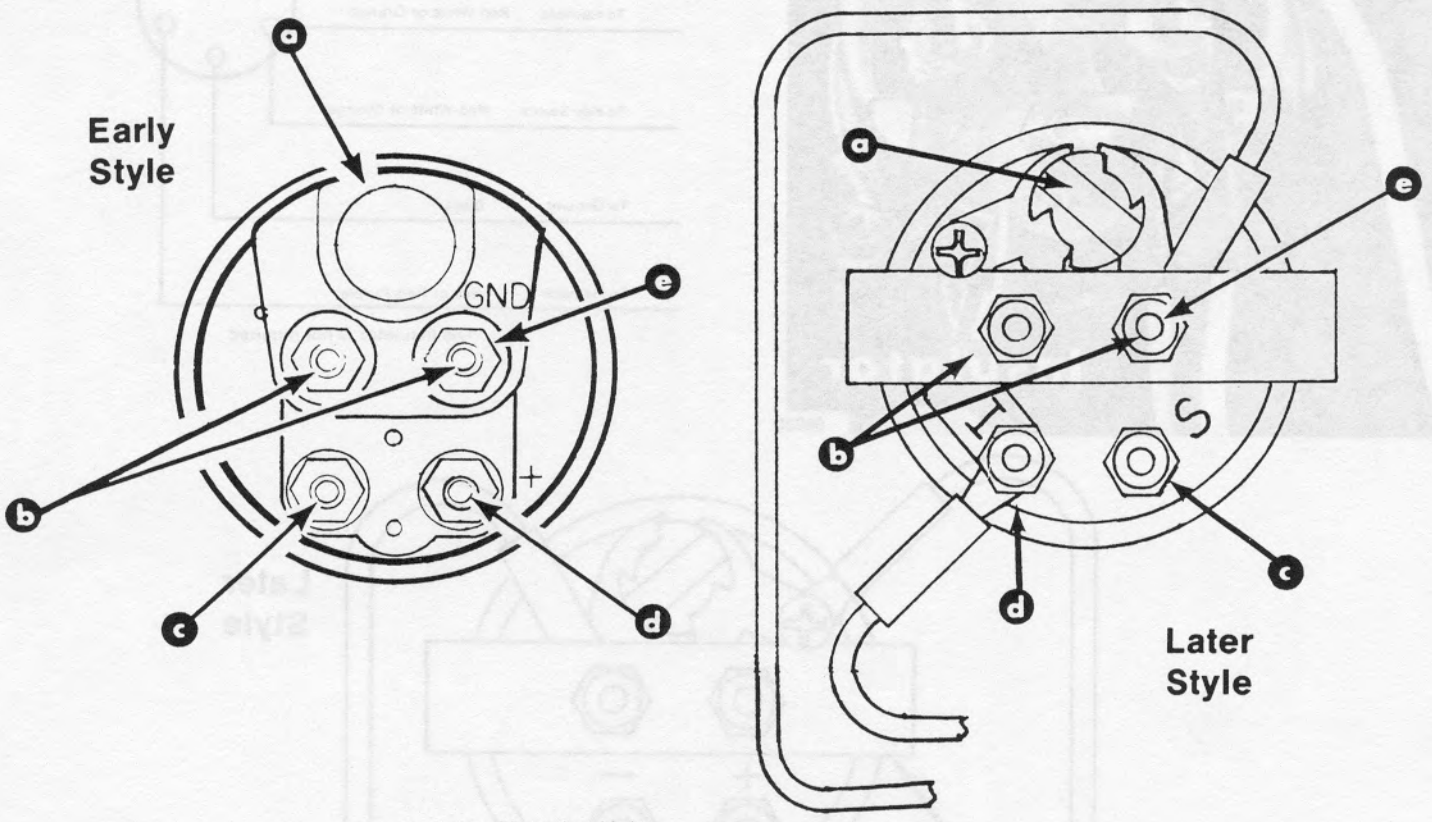
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*



Dual Station Wiring Diagram
When Neutral Safety Switch is in Engine Wiring Harness
(Battery Meter Circuit)

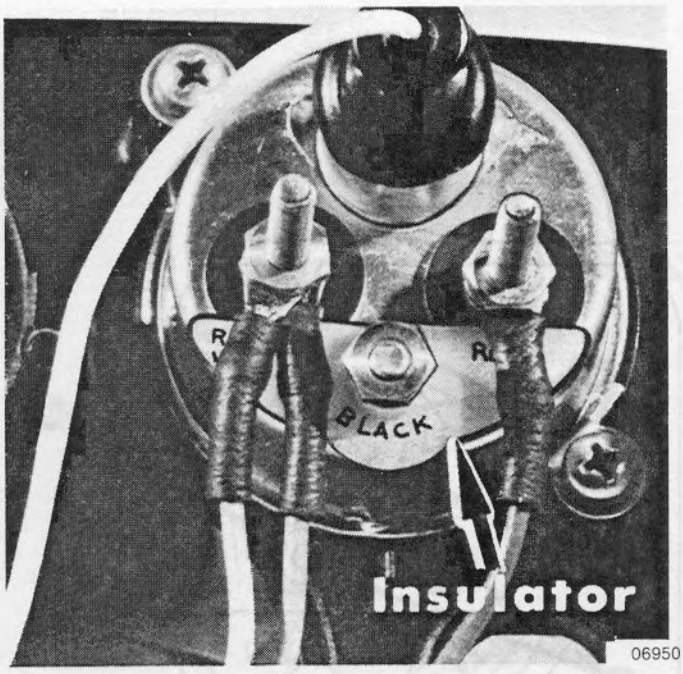
NOTES:

1. *Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).*
2. *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.*
3. *Tape back and insulate with at least 4 layers of electrical tape.*

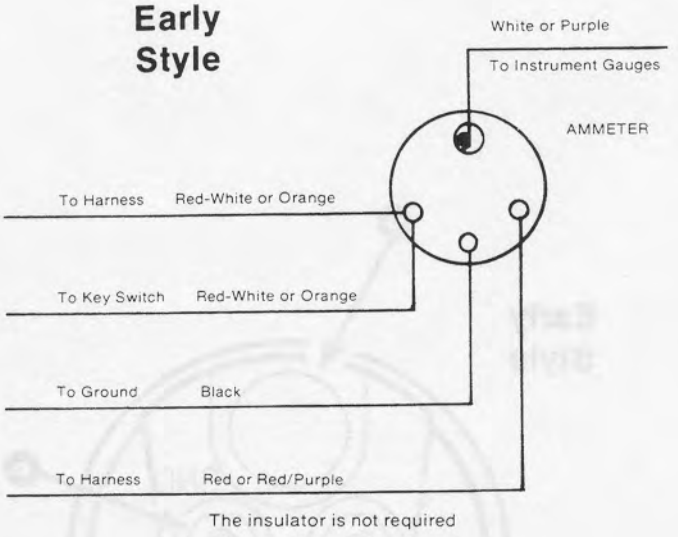


a - Lamp Mounting Hole
b - Gauge Mounting Studs
c - Terminal Not Used
d - Purple (or White) Jumper Wire from This Terminal to I (or +) Terminal on Water Temperature or Oil Pressure Guage
e - Black Jumper Wire from This Terminal to Ground Terminal on Water Temperature or Oil Pressure Gauge

Battery Meter Gauges

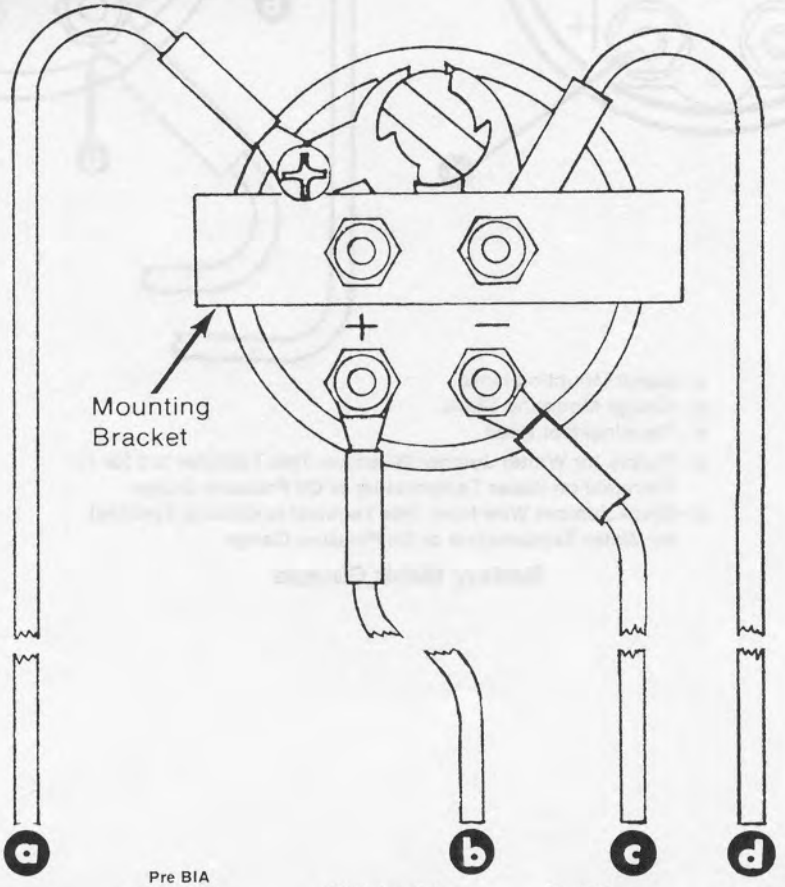


Early Style



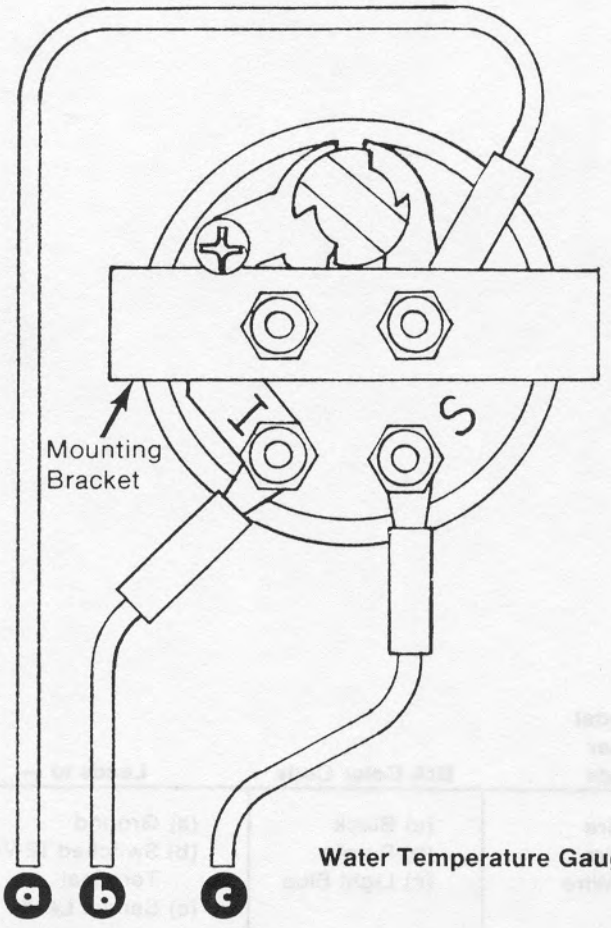
The insulator is not required

Later Style



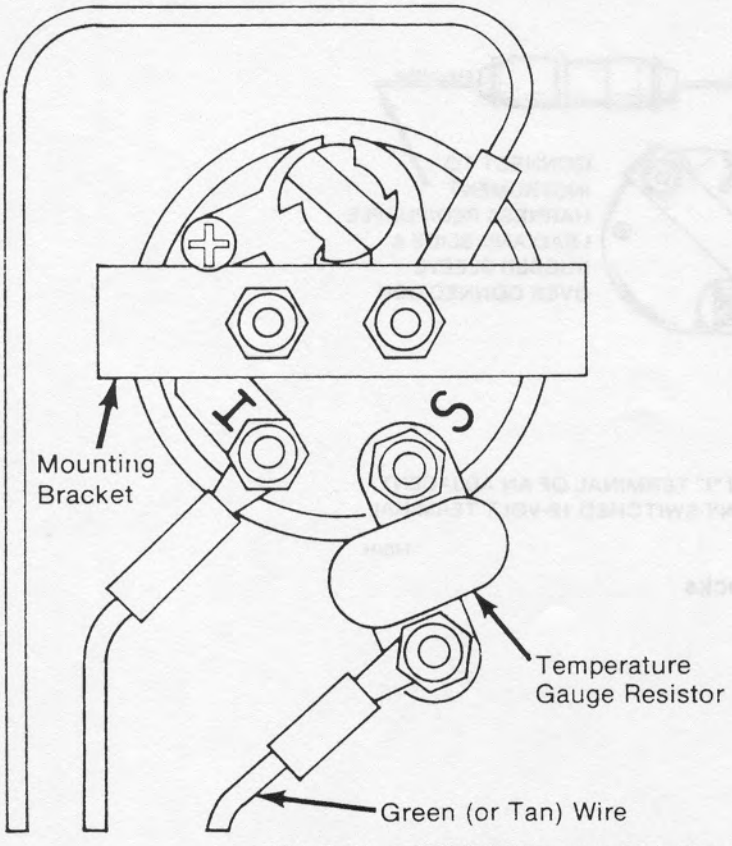
Pre BIA Color Code	BIA Color Code	Leads to —
a. White Wire Jumper (Supplied in Kit) That Is Connected to Nearest 12-Volt Supply	a. Purple Wire	a. To 12-Volt Switched Terminal on Adjacent Gauge or to Accessory Side of Ignition Switch
b. Red with White Stripe Wire	b. Orange Wire	b. To "Batt" Side of Alternator
c. Red Wire	c. Red with Purple Stripe Wire	c. To Battery or to "Batt" Side of Starter Solenoid
d. Black Wire	d. Black Wire	d. To Ground

Ammeter Gauges

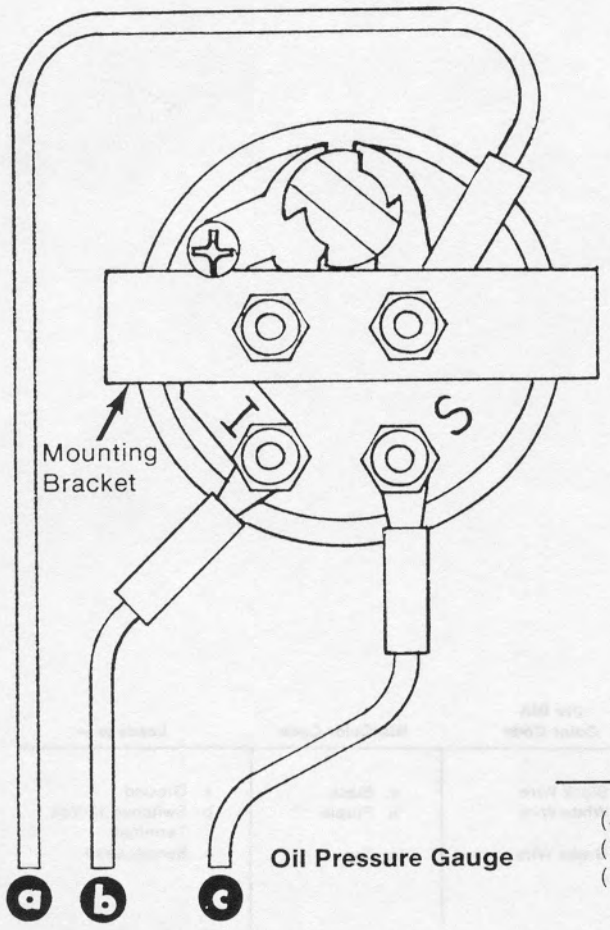


Water Temperature Gauge

Pre BIA Color Code	BIA Color Code	Leads to —
a. Black Wire	a. Black	a. Ground
b. White Wire	b. Purple	b. Switched 12-Volt Terminal
c. Green Wire	c. Tan	c. Sender Lead

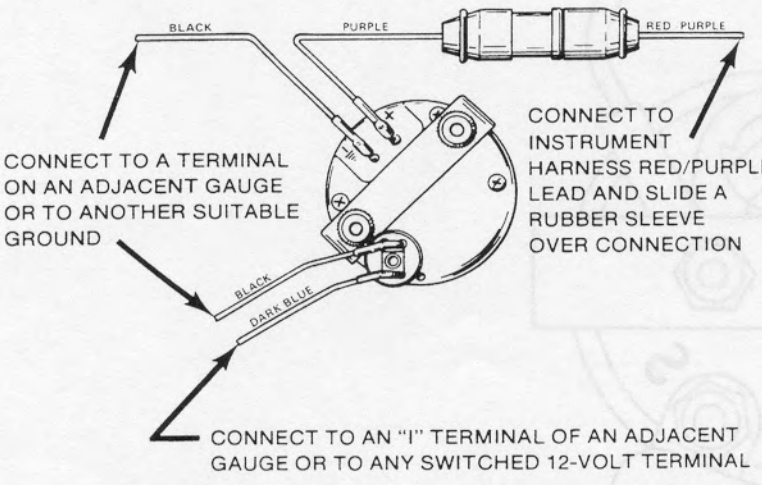


MerCruiser 470/485 Temperature Gauge Resistor Kit (82-88645A3) Installed, If So Equipped



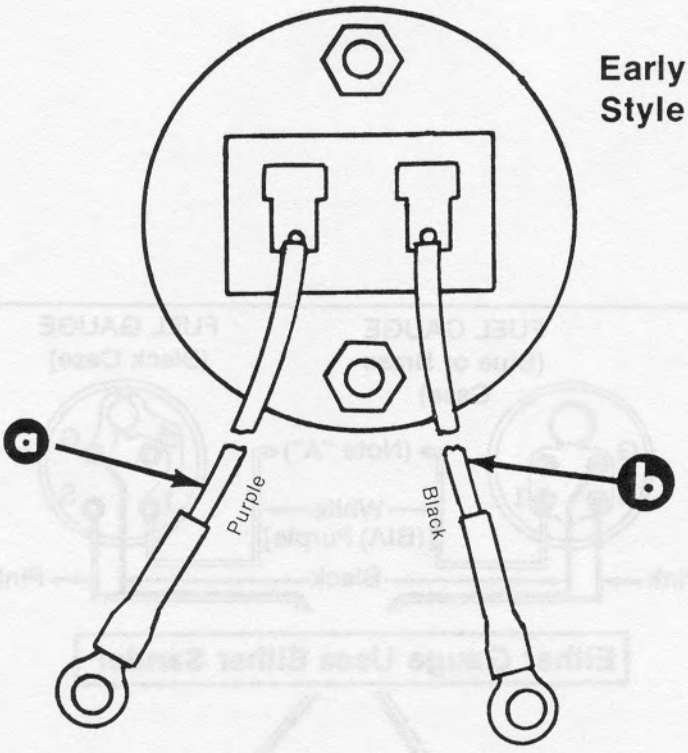
Oil Pressure Gauge

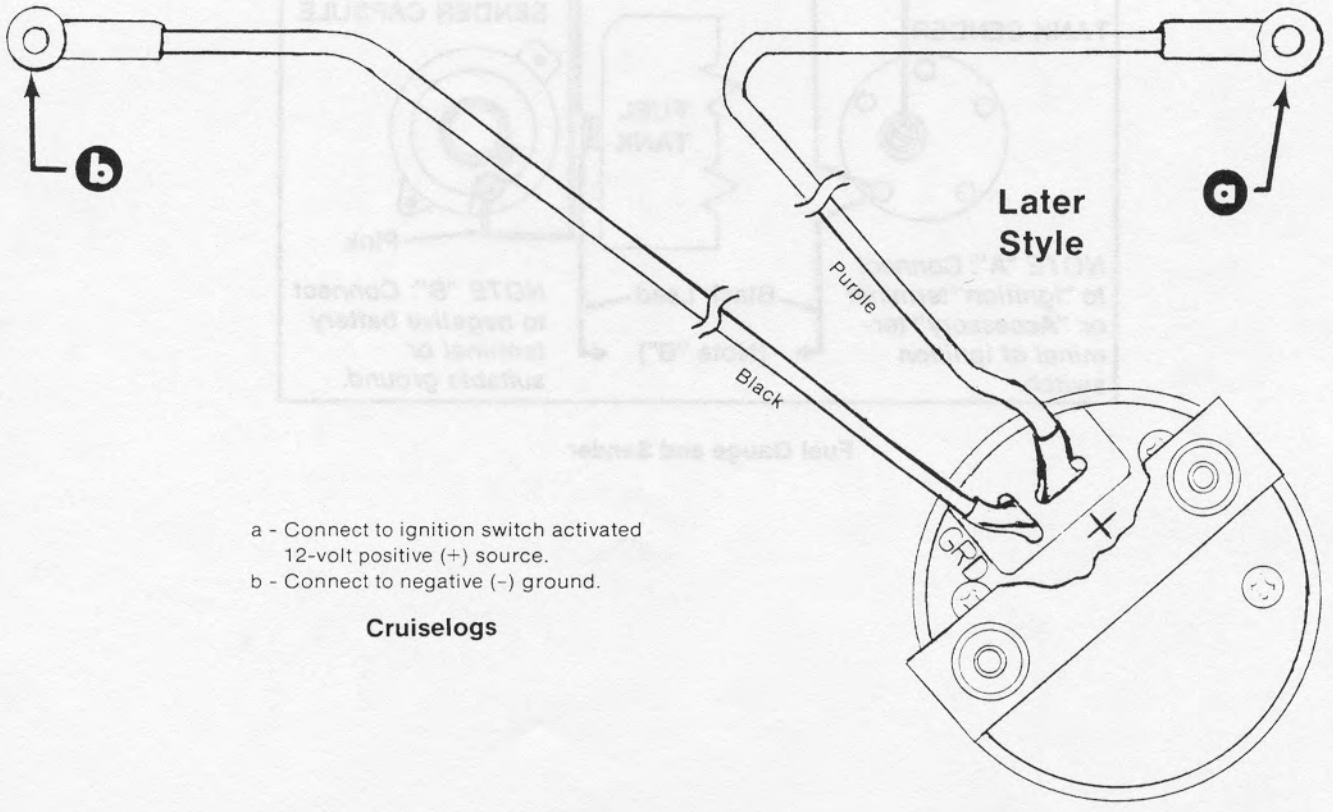
Earlier Model MerCruiser Color Code	BIA Color Code	Leads to —
(a) Black Wire	(a) Black	(a) Ground
(b) White Wire	(b) Purple	(b) Switched 12-Volt Terminal
(c) Orange Wire	(c) Light Blue	(c) Sender Lead



140-H

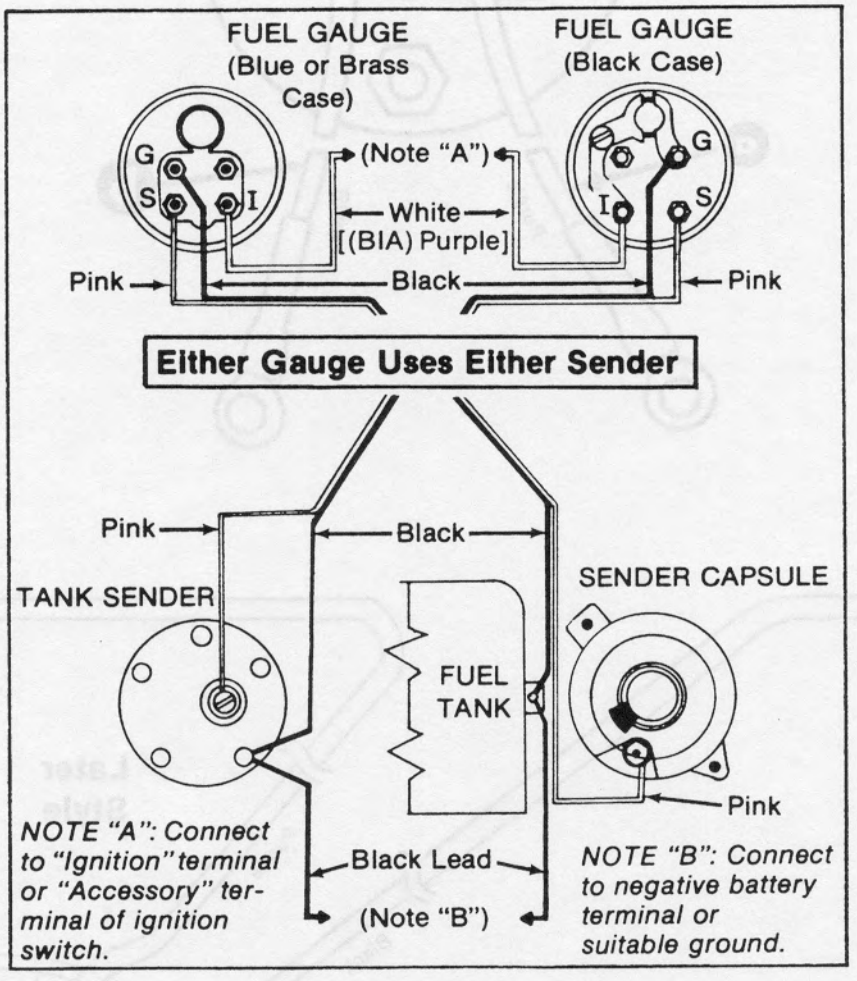
Clocks



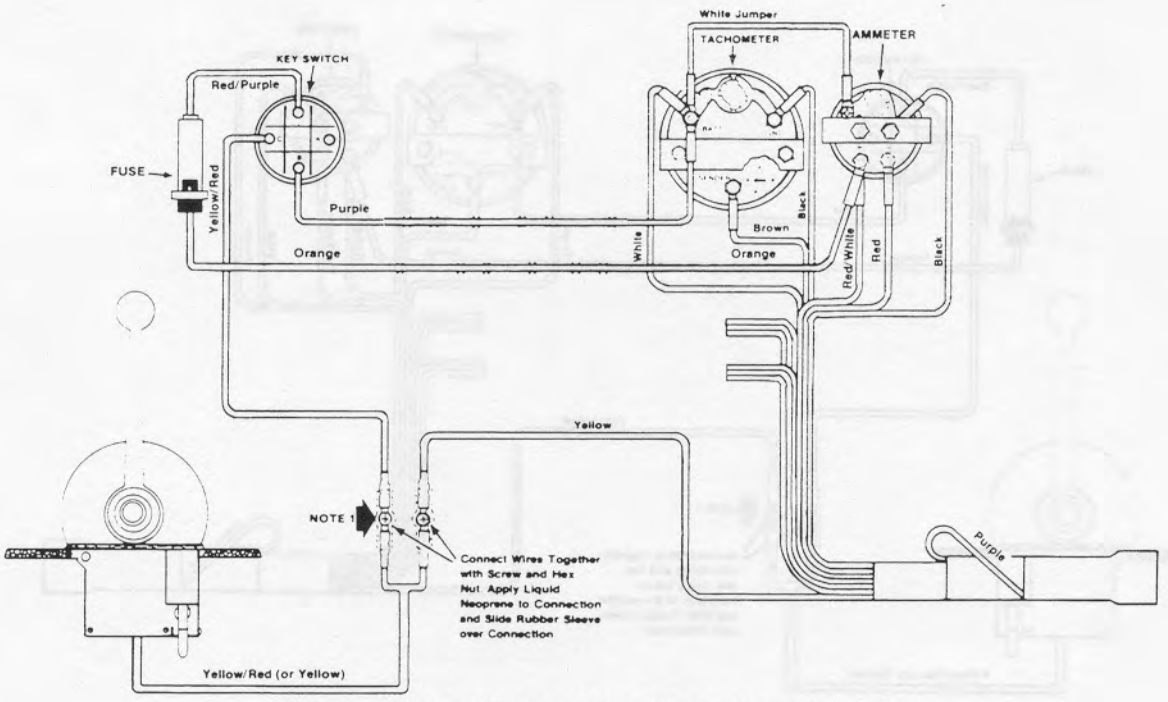


a - Connect to ignition switch activated 12-volt positive (+) source.
b - Connect to negative (-) ground.

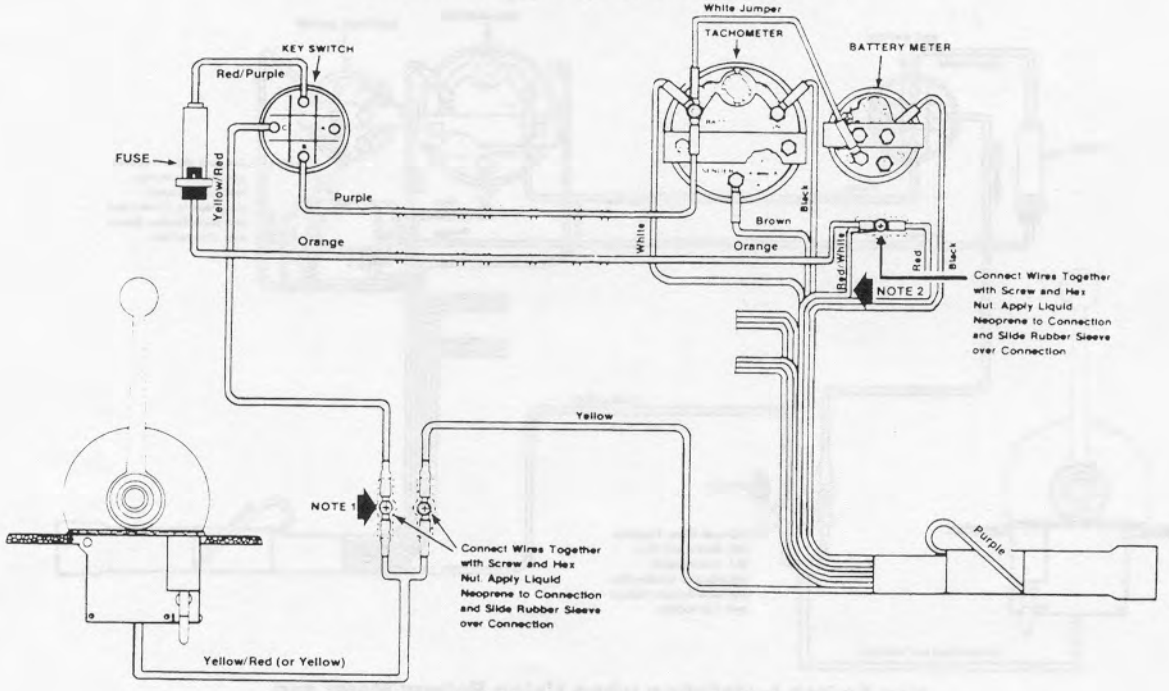
Cruiselogs



Fuel Gauge and Sender



Key Switch Installation when Using Ammeter and Pre BIA Color-Coded Wiring Harness



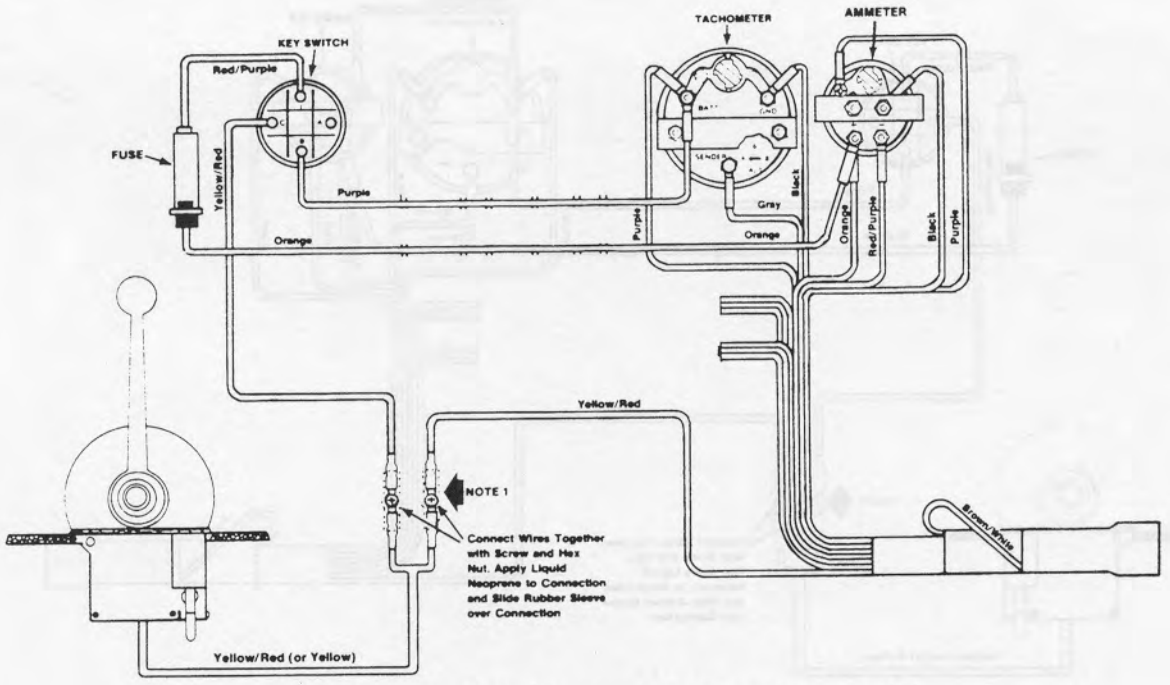
Key Switch Installation when Using Battery Meter and Pre BIA Color-Coded Wiring Harness

⚠CAUTION

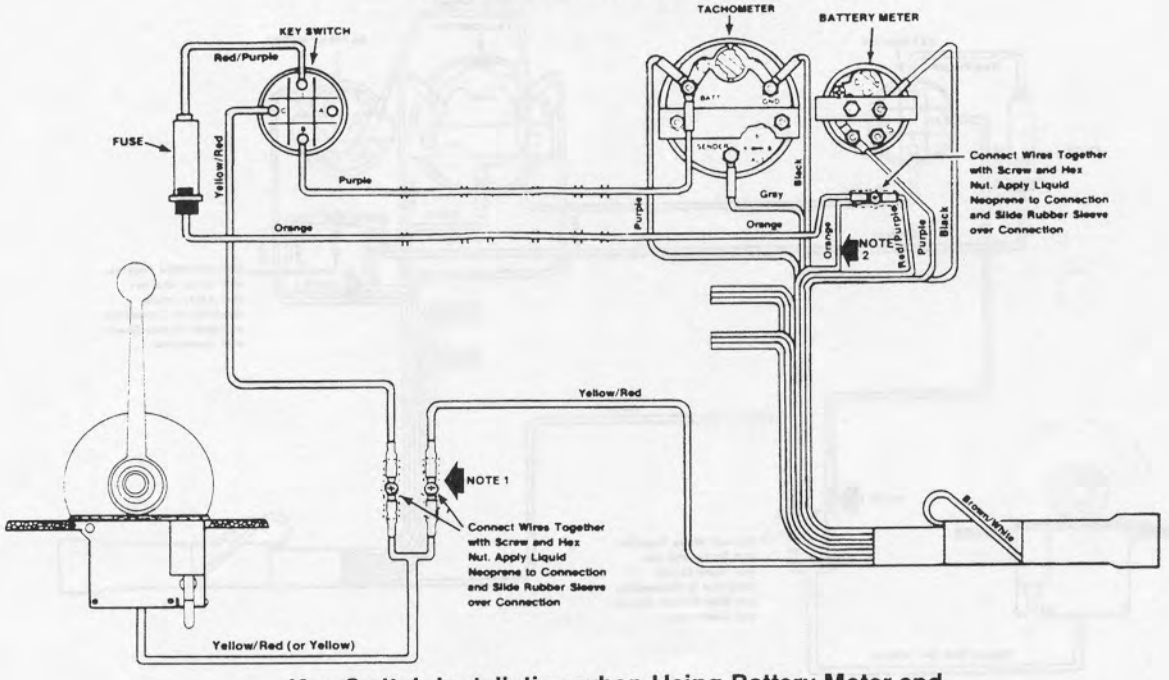
Neutral start safety switch MUST BE USED in cranking circuit. If remote control does not incorporate this switch, it must be part of engine wiring.

NOTE 1. If engine is equipped with a neutral safety switch (on the engine or transmission), connect yellow/red ignition switch wire directly to yellow/red wiring harness wire with screw, nut and sleeve. A neutral safety switch MUST BE used in starting circuit to prevent accidental starting of engine when in gear.

2. On MerCruiser 470 and 485 models, DO NOT connect red/white wire. Tape back and insulate ring terminal with at least 4 layers of electrical tape.



Key Switch Installation when Using Ammeter and BIA Color-Coded Wiring Harness



Key Switch Installation when Using Battery Meter and BIA Color-Coded Wiring Harness

⚠CAUTION

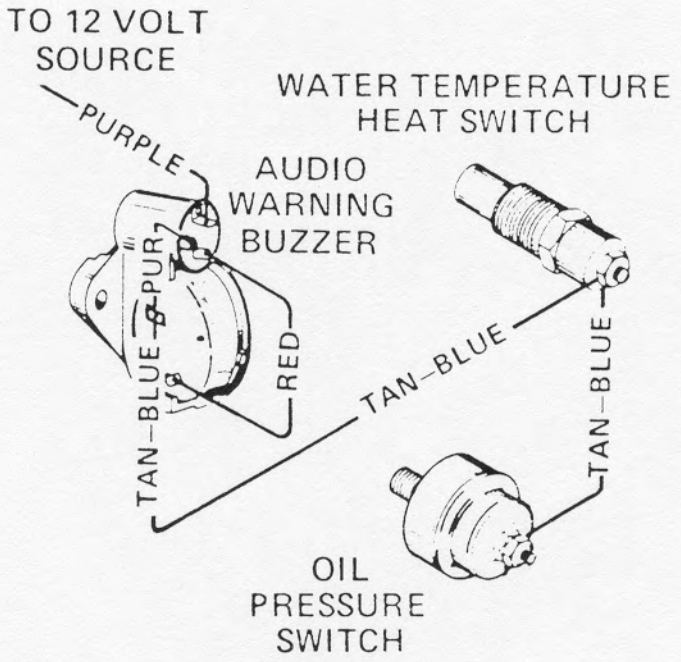
Neutral start safety switch MUST BE USED in cranking circuit. If remote control does not incorporate this switch, it must be part of engine wiring.

NOTE 1. If engine is equipped with a neutral safety switch (on the engine or transmission), connect yellow/red ignition switch wire directly to yellow/red wiring harness wire with screw, nut and sleeve. A neutral safety switch MUST BE used in starting circuit to prevent accidental starting of engine when in gear.

2. On MerCruiser 470 and 485 models, DO NOT connect orange wire. Tape back and insulate ring terminal with at least 4 layers of electrical tape.

⚠WARNING

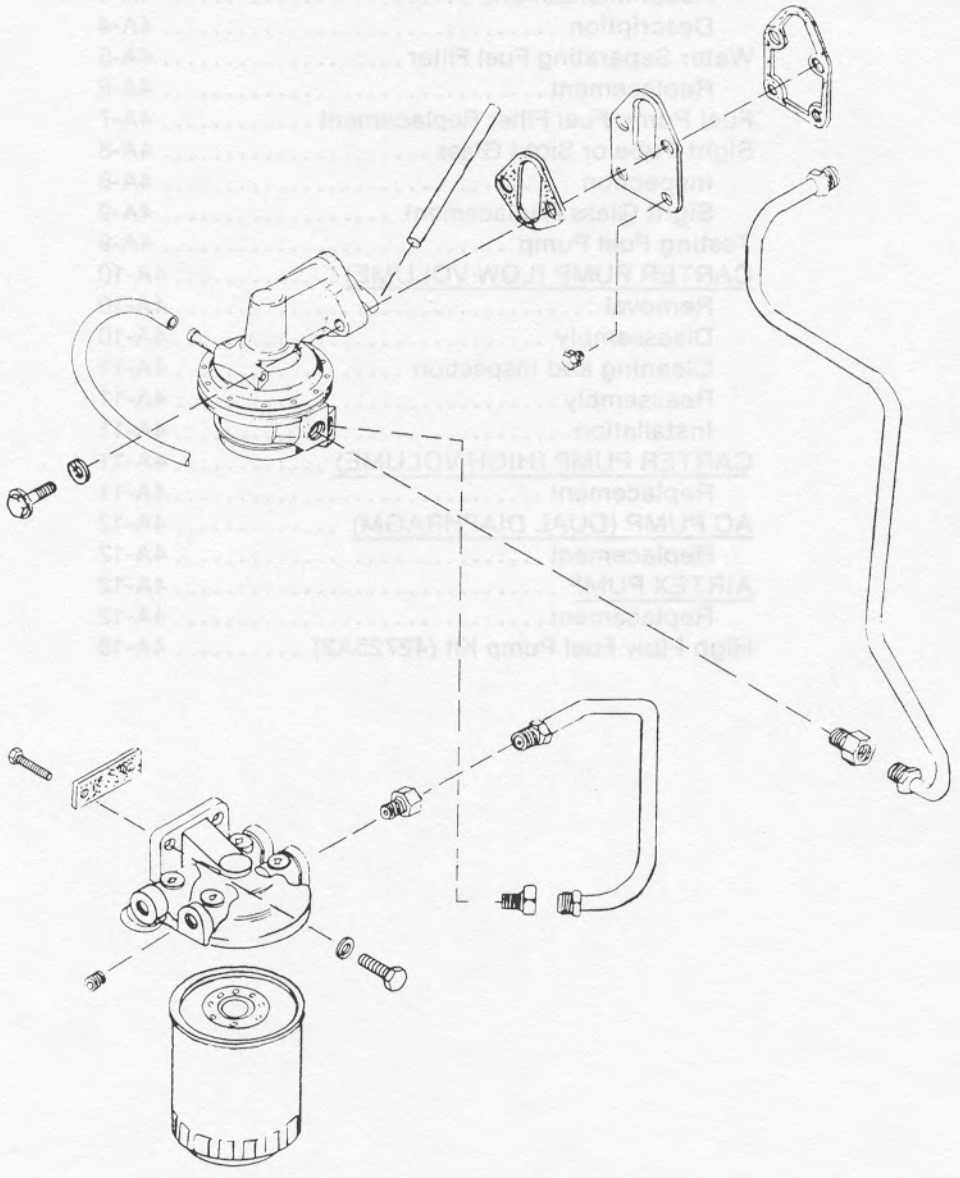
Buzzer is not external ignition-proof, therefore, DO NOT mount buzzer in engine or fuel tank compartments.



Audio Warning System Wiring Diagram

SECTION 4 - FUEL SYSTEM

PART A - FUEL DELIVERY SYSTEM and FUEL PUMPS



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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IDENTIFICATION

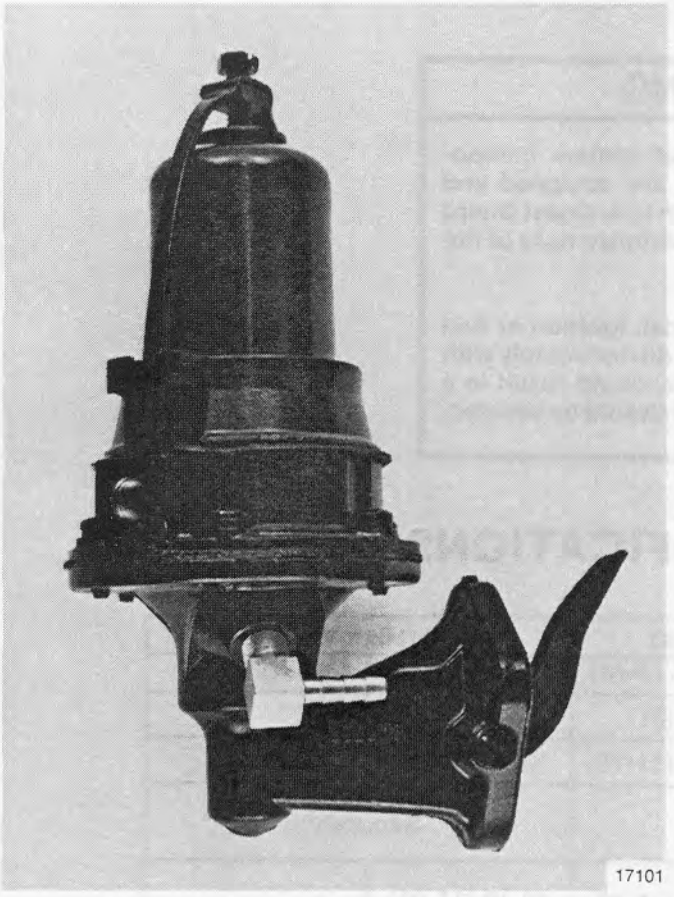


Figure 1. Carter Pump (Low Volume)

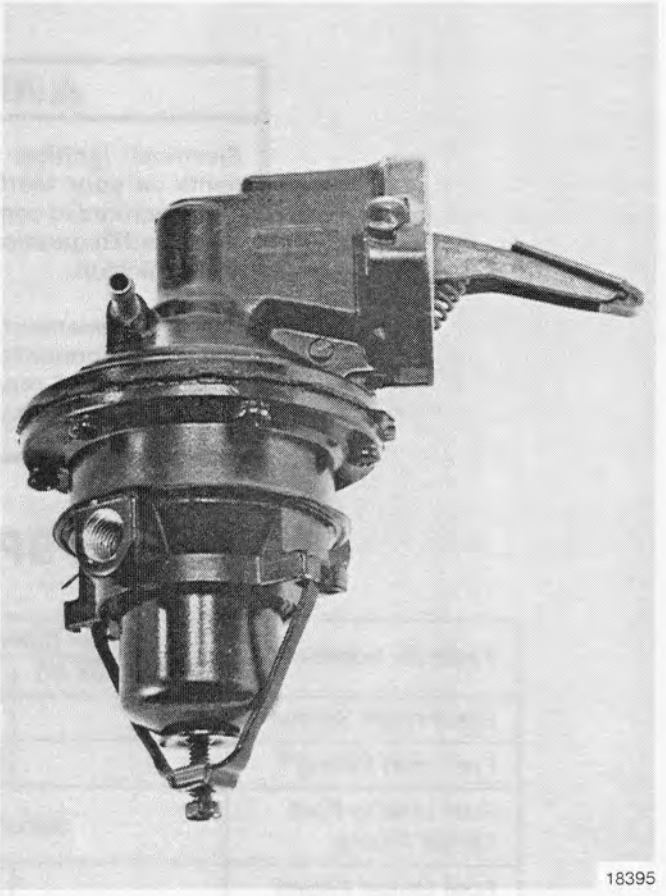


Figure 2. Carter Pump (High Volume)

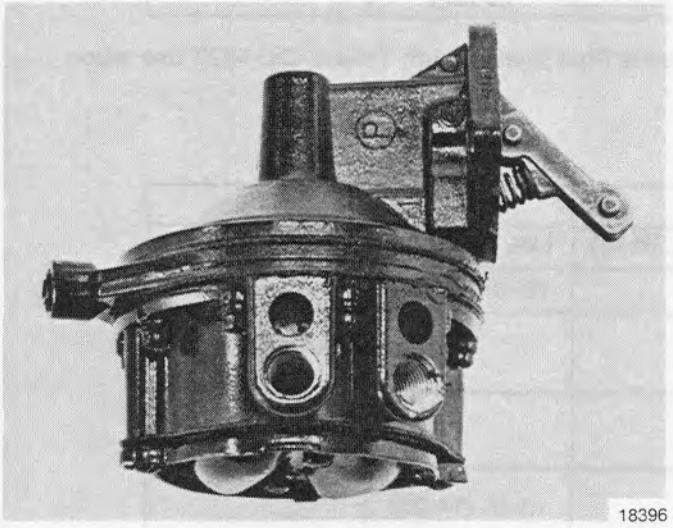


Figure 3. AC Pump (Dual Diaphragm)

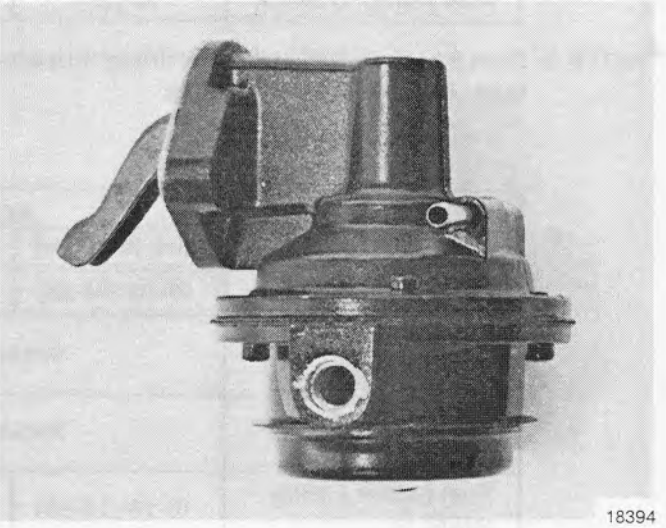


Figure 4. Airtex Pump

REPLACEMENT PARTS WARNING

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

TORQUE SPECIFICATIONS

Fastener Location	Carter (Low Volume)		Carter (High Volume)	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Diaphragm Screws		30 (3)		
Fuel Inlet Fitting*		95-130 (11-15)	10-18 (14-25)	
Fuel Line to Fuel Outlet Fitting	Securely		Securely	
Fuel Outlet Fitting (Note 1)*		95-130 (11-15)	10-18 (14-25)	
Fuel Pump to Block	20 (27)		20 (27)	

*NOTE 1: Coat fuel line inlet and outlet fitting threads with Loctite Pipe Sealant with Teflon, DO NOT use teflon tape. Torque to specifications.

Fastener Location	AC		Airtex	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Fuel Inlet Fitting*	10-18 (14-25)		10-18 (14-25)	
Fuel Line to Fuel Inlet Fitting	Securely		Securely	
Fuel Line to Fuel Outlet Fitting	Securely		Securely	
Fuel Outlet Fitting (Note 1)	10-18 (14-25)		10-18 (14-25)	
Fuel Pump to Block	20 (27)		20 (27)	
Sight Bulb to Fuel Pump	Securely		Securely	

*NOTE 1: Coat fuel line inlet and outlet fitting threads with Loctite Pipe Sealant with Teflon, DO NOT use teflon tape. Torque to specifications.

TOOLS/LUBRICANTS/SEALANTS

TOOLS OBTAINED LOCALLY
Fuel Pressure Gauge

LUBRICANTS/SEALANTS	
92-34227	Quicksilver Perfect Seal
92-42649	Quicksilver Needle Bearing Gasket

SEALANTS OBTAINED LOCALLY
Loctite Pipe Sealant with Teflon

SPECIFICATIONS

Type of Fuel Pump	Carter (Low Volume)	Carter (High Volume)	AC	Airtex
Pump Pressure (1000 RPM)	5.0-6.5 PSI (35-44 kPa)			
Pump Pressure (1800 RPM)		5.25 - 6.5 PSI (36-44 kPa)	5.25 - 6.5 PSI (36-44 kPa)	5.5 - 7.0 PSI (38-48 kPa)
Push Rod Length			5.76 in. (146.304mm)	5.76 in. (146.304mm)
Push Rod Movement			.344 in. (8.7376mm)	.344 in. (8.7376mm)

PRECAUTIONS

⚠WARNING

ALWAYS disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump or pump impeller will be damaged, and subsequent overheating damage may result.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while working. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure that no fuel leaks exist, before closing engine hatch.

FUEL DELIVERY SYSTEM

RECOMMENDATIONS

⚠WARNING

Boating industry standards (BIA, ABYC, etc.) federal standards and Coast Guard regulations MUST BE adhered to when installing fuel delivery system.

When designing and installing fuel delivery system, the following information MUST BE observed:

1. Fuel tank should be mounted below carburetor level, if possible. If tank is mounted above carburetor level, gravity feed may cause carburetor fuel inlet needle to unseat, and flooding may result.
2. Fuel pickup should be at least 1" (25mm) from the bottom of the fuel tank to prevent picking up water or other impurities.
3. Fuel lines used MUST BE Coast Guard approved (USCG type A) and MUST NOT BE SMALLER THAN 5/16" (8mm) ID. On installations where long lines or numerous fittings are required, larger size lines should be used.
4. Fuel line should be installed free of stress and firmly secured to prevent vibration and/or chafing.
5. Sharp bends in fuel line should be avoided.
6. A flexible fuel line must be used to connect fuel line to engine to absorb deflection when engine is running.

DESCRIPTION

The fuel system consists of a fuel tank(s), a water separating fuel filter (if so equipped), a fuel pump, and a carburetor.

The fuel is stored in the fuel tank. When the engine is cranking or running, fuel is drawn from the fuel tank, through the water separating filter (if so equipped), by a mechanically operated fuel pump. The fuel pump is operated by the engine camshaft.

The fuel is pushed through the fuel pump to the carburetor where it is metered and fed to the engine.

WATER SEPARATING FUEL FILTER

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

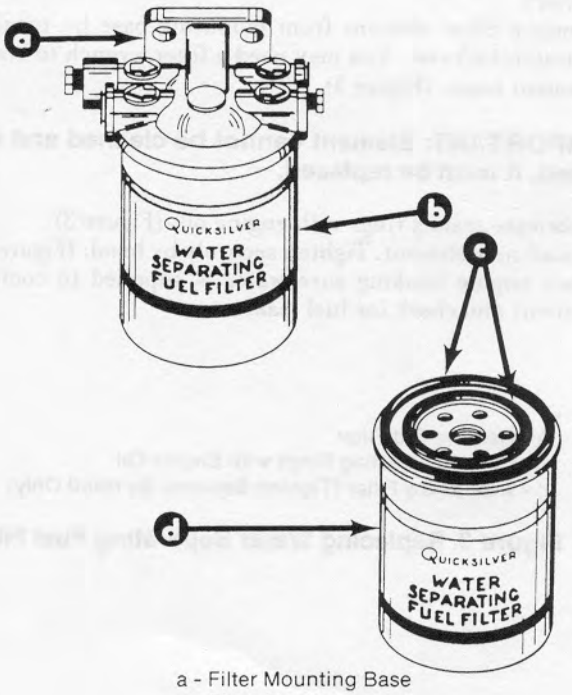
The water separating fuel filter is standard on some engines and can also be purchased as an option for engines not equipped with it.

The fuel filter consists of the fuel filter base and filter element (Figure 1).

IMPORTANT: If installing water separating fuel filter as an option, filter should be located between fuel tank and fuel pump. Also fuel inlet and outlet lines must be connected correctly for filter to work properly. (Figure 2) Follow instructions supplied with water separating fuel filter kit.

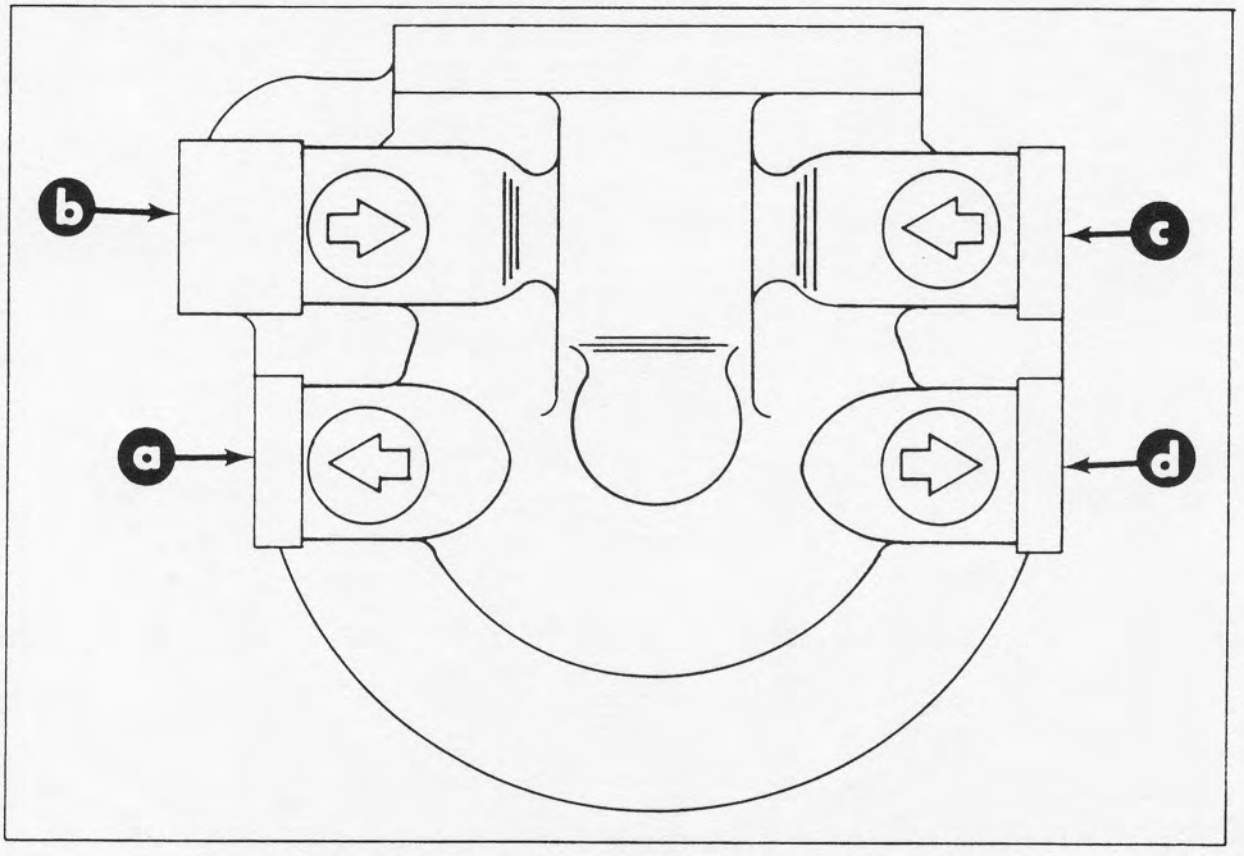
⚠CAUTION

Coat fuel line fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.



a - Filter Mounting Base
b - Filter Element
c - Sealing Rings
d - Replacement Element

Figure 1.



a - Fuel Outlet if "C" is the Inlet
b - Fuel Inlet if "D" is the Outlet
c - Fuel Inlet if "A" is the Outlet
d - Fuel Outlet if "B" is the Inlet

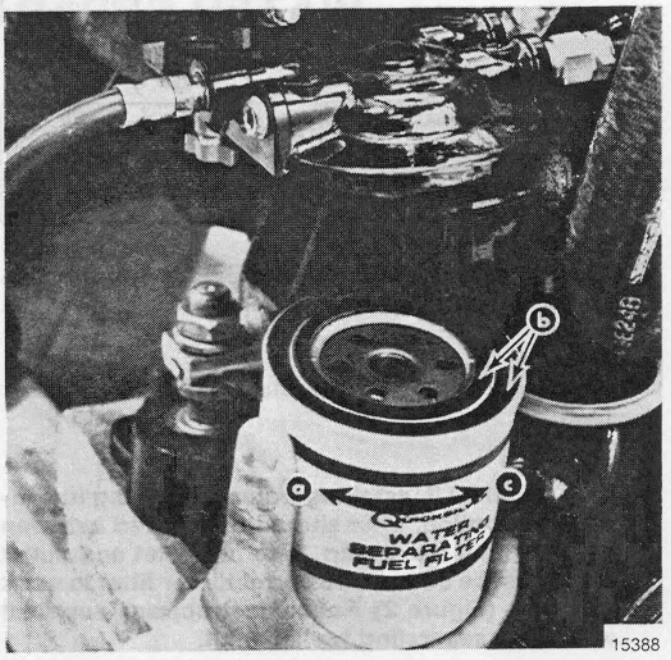
Figure 2.

REPLACEMENT

1. Disconnect negative and positive battery leads from battery.
2. Remove filter element from mounting base by turning counterclockwise. You may need a filter wrench to break element loose. (Figure 3)

IMPORTANT: Element cannot be cleaned and re-used, it must be replaced.

3. Lubricate sealing rings with engine oil. (Figure 3)
4. Install new element. Tighten securely by hand. (Figure 3)
5. Start engine (making sure water is supplied to cooling system) and check for fuel leaks.



a - Remove Old Filter
b - Lubricate Sealing Rings with Engine Oil
c - Install New Filter (Tighten Securely By Hand Only)

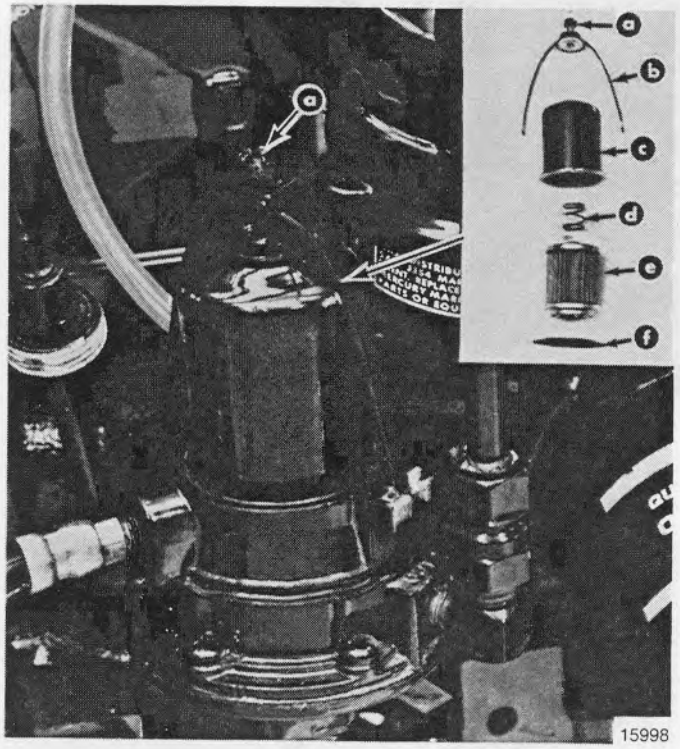
Figure 3. Replacing Water Separating Fuel Filter

FUEL PUMP FUEL FILTER REPLACEMENT

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

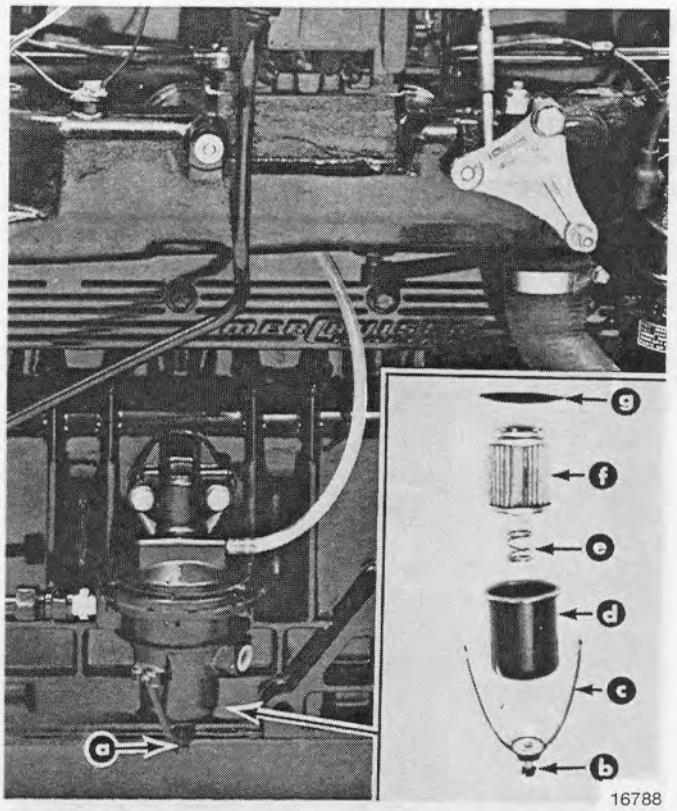
IMPORTANT: AC or Airtex pumps do not have a filter in the fuel pump.

1. Remove safety wire.
2. Loosen screw above filter bowl and release bail from fuel pump housing.



a - Retaining Screw (Lockwired)
b - Bail - Hook Ends in Slots
c - Filter Bowl
d - Spring
e - Filter Element - Open End of Filter TOWARD PUMP
f - New Gasket

Figure 1. Carter Pump (Low Volume)



a - Lockwire
b - Retaining Screw
c - Bail - Hook Ends in Slots
d - Filter Bowl
e - Spring
f - Filter Gasket - Open End at Filter TOWARD PUMP
g - New Gasket

Figure 2. Carter Pump (High Volume)

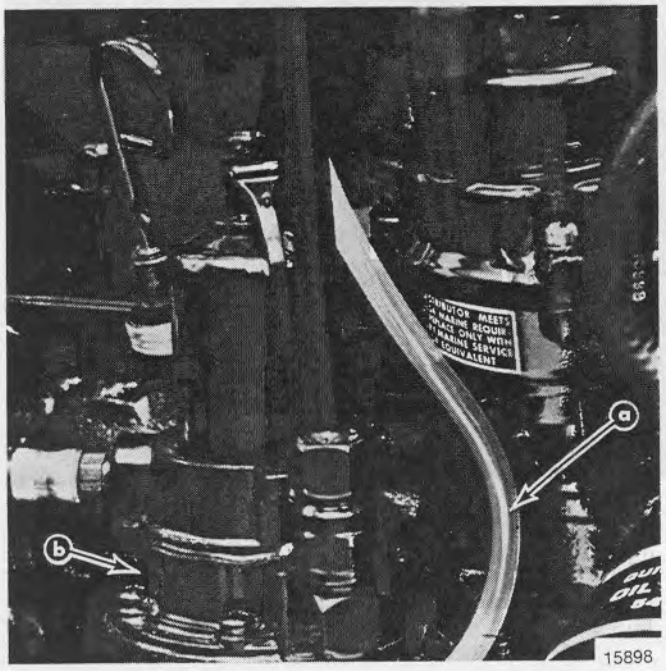
3. Remove bowl, filter element, spring, and gasket from fuel pump.
4. Install new filter as shown in Figure 1 or 2.
5. Tighten retaining screw securely.
6. Install safety wire and tighten securely.
7. Start and run engine.
8. Check for gasoling leaks.
9. If leaks exist, STOP ENGINE and recheck connections.

SIGHT TUBE or SIGHT GLASS

INSPECTION

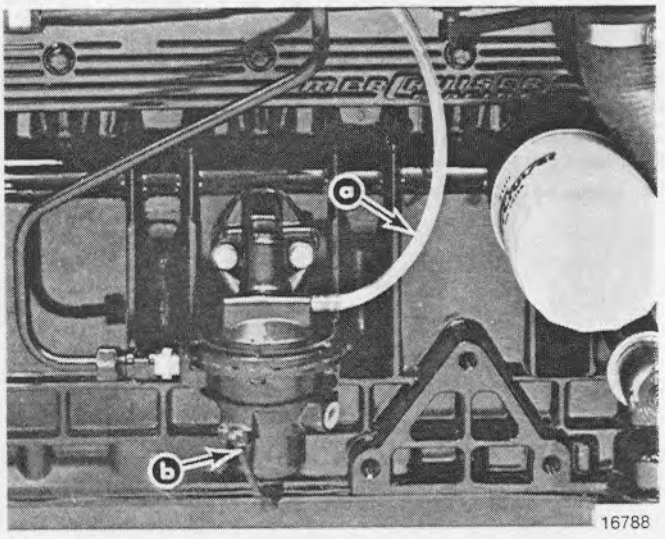
Fuel pumps are equipped with a sight tube (Figures 1, 2, 3) or a sight glass. (Figure 4) Any evidence of fuel in the sight tube or sight glass indicates a ruptured diaphragm and fuel pump must be replaced immediately.

IMPORTANT: The low volume Carter Pump can be repaired with a diaphragm kit. All other fuel pumps must be replaced as an assembly.



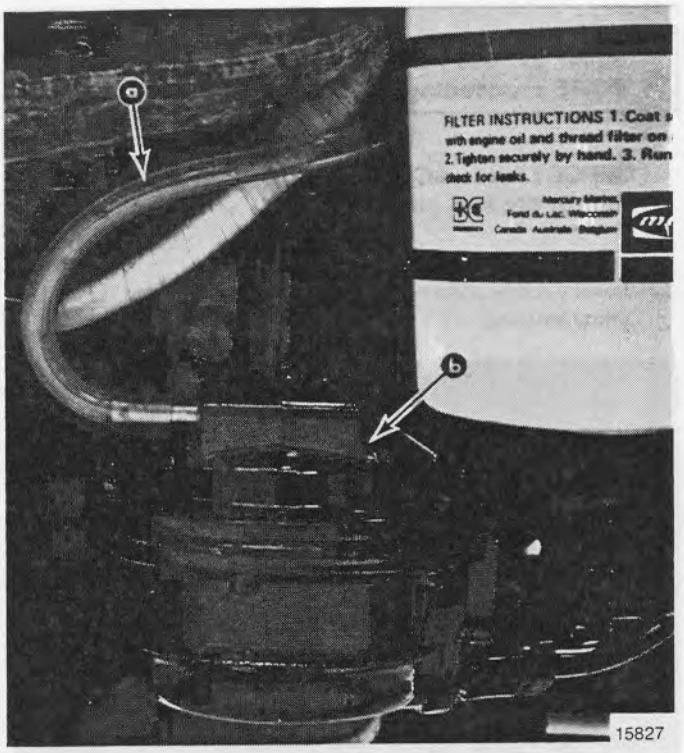
a - Sight Tube
b - Fuel Pump

Figure 1. Carter Pump (Low Volume)



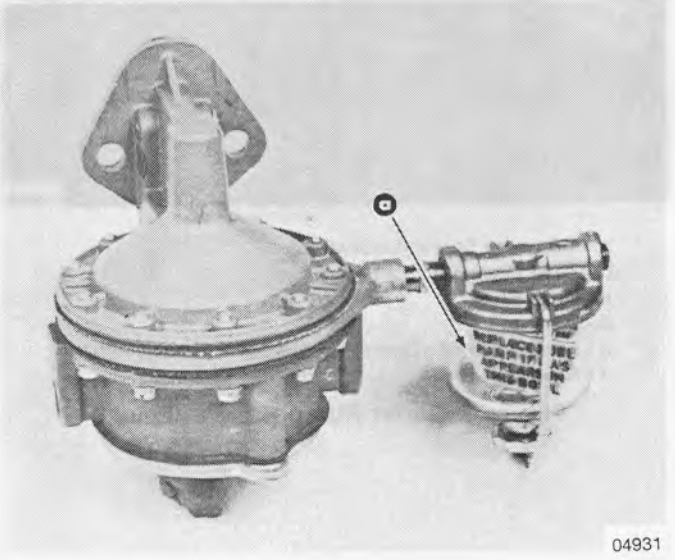
a - Sight Tube
b - Fuel Pump

Figure 2. Carter Pump (High Volume)



a - Sight Tube
b - Fuel Pump

Figure 3. Airtex Pump



a - Sight Glass

Figure 4. AC Pump (Dual Diaphragm)

SIGHT GLASS REPLACEMENT

1. Remove sight glass from fuel pump by turning fitting with a wrench.
2. Remove fitting by turning fitting out of sight glass.
3. Coat threads of fitting with sealer and install fitting into sight glass. Tighten securely.
4. Coat threads of fitting with sealer and install fitting into fuel pump with a wrench. Tighten securely.

⚠CAUTION

Coat fuel line inlet fitting threads Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

TESTING FUEL PUMP

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove fuel line from outlet side of fuel pump.
2. Install fuel pressure test gauge to outlet side of fuel pump using T-fitting and appropriate adaptors.
3. Connect fuel line (previously removed from pump) to other side of T-fitting on fuel pressure test gauge using appropriate adaptors.
4. Start engine and run at R.P.M. listed in specifications.
5. Fuel pressure should be within specifications. If not, repair or replace fuel pump.
6. Remove fuel pressure gauge and adaptors. Reconnect fuel line to fuel pump. Tighten to specifications.

CARTER PUMP (LOW VOLUME)

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

REMOVAL

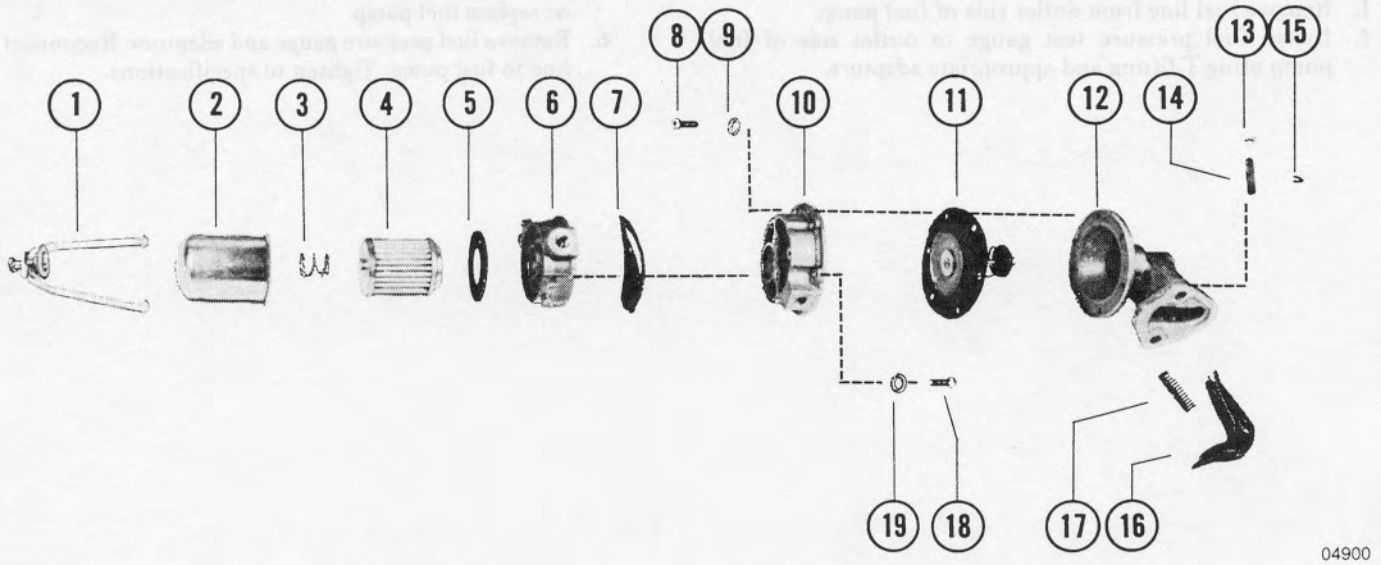
⚠CAUTION

Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

1. Disconnect fuel inlet and outlet lines at fuel pump.
2. Remove sight tube.
3. Remove 2 fuel pump mounting bolts and lockwashers, pump and gasket.

DISASSEMBLY

1. Mark edges of fuel cover and body flange. Parts then may be reassembled in same relative position.
2. Loosen screw and remove filter holder, filter and gasket.
3. Remove screws, then pump body.
4. Remove screws and lockwasher and separate lower housing, pulsator, diaphragm and valve housing.
5. Remove spring, rocker arm shaft plug, safety pin, rocker arm shaft and rocker arm from main body.
6. Remove diaphragm seal assembly.



1 - Filter Cover Retainer
2 - Filter Cover
3 - Filter Spring
4 - Filter
5 - Filter Gasket
6 - Pulsator Housing
7 - Pulsator
8 - Screw
9 - Lockwasher
10 - Valve Body
11 - Diaphragm
12 - Pump Body
13 - Rocker Arm Pin Plug
14 - Rocker Arm Pin
15 - Rocker Arm Retainer
16 - Rocker Arm
17 - Rocker Arm Spring
18 - Screw
19 - Lockwasher

Figure 1. Low Volume Carter Fuel Pump

CLEANING and INSPECTION

1. Clean and rinse all metal parts in solvent. Blow out all passages with compressed air.
2. Inspect pump body and fuel cover for cracks, breakage and distorted flanges. Examine all screw holes for stripped or crossed threads. **Replace pump assembly if one of main castings is not serviceable.**
3. Inspect rocker arm and link for excessive wear and for loose hinge pin.
4. Use proper diaphragm repair kit to replace diaphragm.
5. Replace rocker arm spring and diaphragm springs as removed. Old springs may be distorted, weak or corroded.
6. Check condition of valves by pushing each valve off its seat with a thin rod or pencil. Insert hooked wire thru inlet opening in fuel cover to move fuel inlet valve off its seat. If a valve sticks to its seat, if it moves off its seat and does not rebound or, if cage is damaged, complete valve must be replaced. To remove valves, clear staked metal (with a sharp chisel, file or suitable scraper) and pull valve out with a hook-shaped tool.

REASSEMBLY

1. Replace diaphragm, pulsator, filter gasket and rocker arm shaft plug.
2. Push diaphragm into pump body and install rocker arm so that fork catches diaphragm.
3. Install rocker arm shaft, safety pin and rocker arm shaft plug.
4. Attach valve housing to lower housing with 2 screws.
5. Assemble pump bodies with screws, making sure that marks line up. Torque to specifications.

   IMPORTANT: Diaphragm must be flexed to its full stroke while tightening cover screws, or pump diaphragm protector will not be properly centered, thereby rubbing on the pump body casting and wearing diaphragm.

6. Reassemble filter to pump body, using new filter as previously outlined.

INSTALLATION

1. Install new gasket (coat both sides with Perfect Seal) on fuel pump. Install pump and torque mounting bolts to specifications.
2. Install fuel line to fuel outlet fitting. Tighten securely.
3. Install fuel inlet fitting to fuel pump. Torque to specifications.

⚠CAUTION

Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use feflon tape). Torque to specifications.

4. Install sight tube and fuel supply line.
5. Start engine and check for fuel leaks.

CARTER PUMP (HIGH VOLUME)

NOTICE
Refer to "Precautions", in this section, BEFORE PROCEEDING.

IMPORTANT: The high volume Carter pump cannot be repaired. If fuel pump fails it must be replaced.

REPLACEMENT

1. Remove fuel inlet and outlet lines at fuel pump.
2. Remove sight tube.
3. Remove 2 fuel pump mounting bolts and lockwashers, pump and gasket.

⚠CAUTION

Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

4. Install new gasket (coat both sides with Perfect Seal) on fuel pump. Install pump, and torque mounting bolts to specifications.
5. Install fuel line to fuel outlet fitting. Tighten securely.
6. Install fuel inlet fitting to fuel pump. Torque to specifications.

⚠CAUTION

Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

7. Install sight tube and fuel supply line.
8. Start engine and check for fuel leaks.

AC PUMP (DUAL DIAPHRAGM)

NOTICE
Refer to "Precautions", in this sections, BEFORE proceeding.

IMPORTANT: The AC fuel pump cannot be repaired. If the fuel pump fails it must be replaced.

REPLACEMENT

1. Remove fuel inlet and outlet lines at fuel pump.

⚠CAUTION

Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

2. Remove sight glass as outlined (sight tube on later pumps).
3. Remove 2 fuel pump mounting screws, pump, and gasket.
4. Remove mounting plate bolts, mounting plate, gasket, and push rod.
5. Check push rod length. See Specifications.
6. Check push rod movement by installing push rod in engine, install a dial indicator against end of push rod, and turning engine over one complete revolution. Push rod should have total movement as shown in specifications.
7. Coat push rod with Quicksilver Needle Bearing Grease and install in engine.
8. Apply Perfect Seal to both sides of mounting plate gasket. Then, install gasket, plate, and mounting bolts. Tighten securely.
9. Apply Perfect Seal to both sides of fuel pump gasket.
10. Install gasket, fuel pump and mounting bolts. Torque bolts to specifications.
11. Install fuel inlet and outlet fittings to fuel pump. Torque fittings to specifications. Tighten flare fittings securely.
12. Install sight glass (sight tube on later pumps).
13. Start engine and check for fuel leaks.

⚠CAUTION

Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

AIRTEX PUMP

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

IMPORTANT: The Airtex pump cannot be repaired. If the fuel pump fails it must be replaced.

REPLACEMENT

1. Remove fuel inlet and outlet lines at fuel pump.

⚠CAUTION

Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

2. Remove sight tube.
3. Remove 2 fuel pump mounting screws, pump, and gasket.
4. Remove mounting plate bolts, mounting plate, gasket, and push rod.
5. Check push rod length. See Specifications.
6. Check push rod movement by installing push rod in engine, install a dial indicator against end of push rod, and turning engine over one complete revolution. Push rod should have total movement as shown in specifications.
7. Coat push rod with Quicksilver Needle Bearing Grease and install in engine.
8. Apply Perfect Seal to both sides of mounting plate gasket then install gasket, plate, and mounting bolts. Tighten securely.
9. Apply Perfect Seal to both sides of fuel pump gasket.
10. Install gasket, fuel pump and mounting bolts. Torque to specifications.
11. Install fuel inlet and outlet fittings to fuel pump. Torque fittings to specifications. Tighten flare fittings securely.
12. Install sight tube.
13. Start engine and check for fuel leaks.

⚠CAUTION

Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

HIGH FLOW FUEL PUMP KIT (42725A2)

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

NOTICE to INSTALLER
MCM 485: If this fuel pump is used on an MCM 485, a new 90° fuel inlet fitting (22-68727) also is required.

MCM 488R: If this fuel pump is used on an MCM 488R (serial 6671741 and below), a new fuel line (32-43275A1) also is required.

High flow fuel pump is recommended as an improvement where vapor lock affects engine performance. This pump fits all MCM 470/470R/485/488R stern drive engines (serial 6671741 and below).

REMOVAL OF EXISTING FUEL PUMP

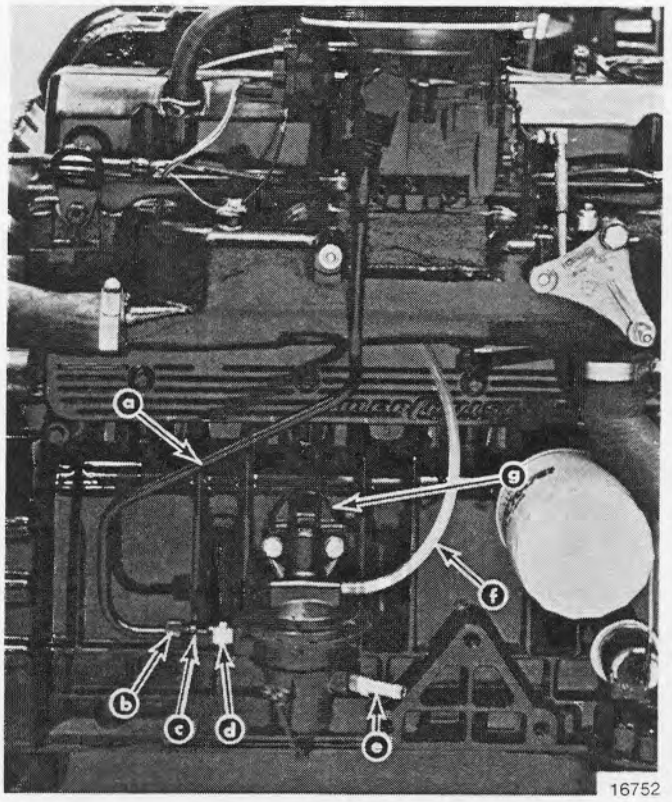
1. Disconnect fuel inlet and outlet lines and sight tube from fuel pump. Remove and discard fuel outlet line.
2. Remove and discard 2 fuel pump mounting screws, 2 lockwashers, pump and gasket. Retain 2 flat washers. Clean gasket surface on cylinder block.

⚠CAUTION

Coat fuel line fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

INSTALLATION OF KIT FUEL PUMP

1. Apply suitable fuel line thread sealant and install outlet fitting (from kit). Torque to specifications.
2. Lubricate rocker arm of kit pump with engine oil. Install pump using new, thick gasket, 2 lockwashers and 2 screws (from kit) plus existing 2 flat washers. Pump filter bowl must be positioned down as shown. Torque screws to specifications.
3. Reconnect sight tube.
4. Install replacement fuel line (from kit on MCM 470, 470R and 485, or obtained separately for MCM 488R). Loosen anti-vibration nut and grommet. Start both threaded ends at same time and check for cross threading. Then tighten securely. Press grommet against fuel outlet nut and secure anti-vibration nut snugly. Do not overtighten.
5. Apply suitable fuel line thread sealant and install fuel inlet fitting. Torque to specifications.
6. Reconnect battery. Start and run engine. Check fuel line connections for gasoline leaks.

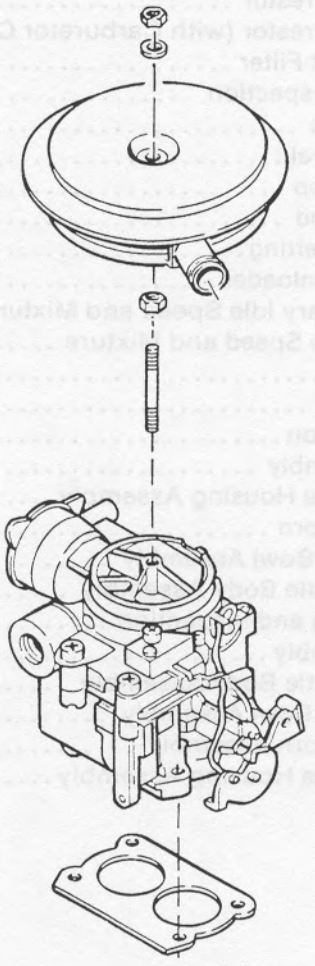


a - Replacement Fuel Line
b - Anti-Vibration Nut
c - Fuel Outlet Nut
d - Fuel Outlet Fitting
e - Fuel Inlet Fitting
f - Sight Tube
g - Gasket

Figure 1. Replacement Fuel Pump with Filter Bowl Inverted

SECTION 4 - FUEL SYSTEM

PART B - ROCHESTER 2-BARREL



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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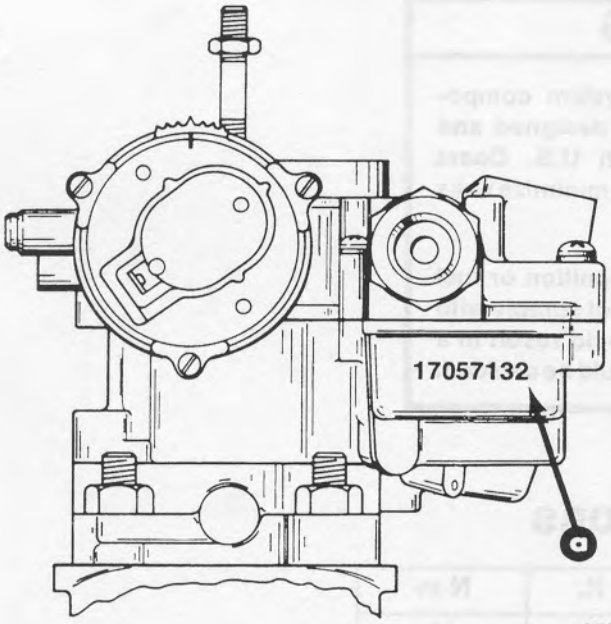
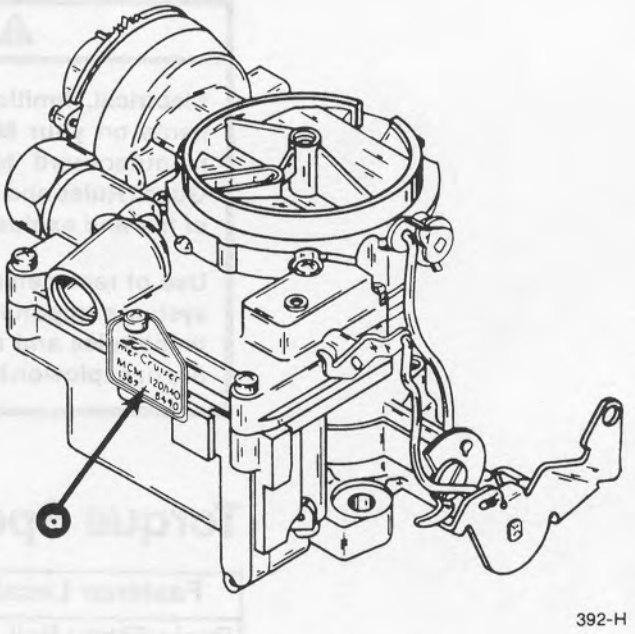
IDENTIFICATION



384-H

a - Part Number

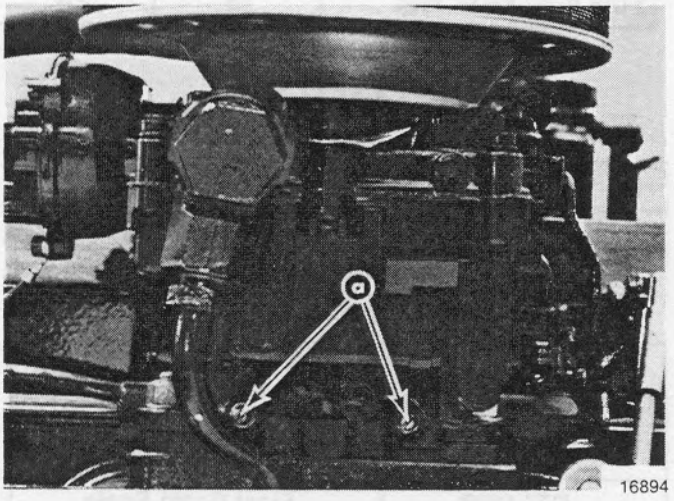
Carburetor Part Number Location



392-H

a - Part Number (Embossed Tag)

Part Number Tag Location



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a - Two Idle Mixture Needles

Rochester 2GC Carburetor

REPLACEMENT PARTS WARNING

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	lb. ft.	N·m
Banjo Fitting Bolt	30	41
Carburetor to Manifold	12	16
Fuel Line to Carburetor	18	24
Fuel Inlet Filter Nut	18	24

TOOLS

MERCURY MARINE SPECIAL TOOLS	
91-59339	Tachometer
91-36392	Universal Carburetor Gauge

Borroughs Tool and Equipment 2429 N. Burdick St. Kalamazoo, MI 49007 (616) 345-5163	
BT8128B	Float Gram Scale

SPECIFICATIONS

CARBURETOR MODEL SPECIFICATIONS					
Model (Serial No.)	**Type (Note 1)**	**Manufacture Number**	**Mercury Number**	**Primary Jet Size**	**Power Valve Size**
MCM 120 (5192047 and Below)	Rochester 2GC	17044182	1351-6065	.062"	.046"
MCM 120 (5192048-6229717)	Rochester 2GC	17059054	1351-7354	.062"	.046"
MCM 120R (6229718 and Above)	Rochester 2GC	17081060	1351-8480	.062"	.052"
MCM 140 (5157668 and Below)	Rochester 2GC	17043184	1351-5203	.062"	.052"
MCM 140 (5157669-6229717)	Rochester 2GC	17059052	1351-7355	.062"	.052"
MCM 140R (6229718 and Above)	Rochester 2GC	17081060	1351-8480	.062"	.052"
MCM 165 (5178958 and Below)	Rochester 2GC	17043183	1351-5204	.061"	.052"
MCM 165 (5178959 and Up)	Rochester 2GC	17059050	1351-7356	.067"	.052"
MCM/MIE 470 - MCM 470R (All)	Rochester 2GC	17057132	1376-5990	.066"	.052"
MCM 485 (All)	Rochester 2GC	17057132	1376-5990	.066"	.052"
MCM 898 (6021383 and Below)	Rochester 2GC	17057139	1376-6491	.066"	.055"
MCM 898R (6021384 and Up)	Rochester 2GC	17080350	1376-8295	.066"	.055"

NOTE 1. All Rochester carburetors are the 2GC type. The "C" designates the type of choke on the carburetor, NOT bore size. This information supercedes all previous Service Bulletins and service information.

UNIT OF MEASUREMENT
in. (mm)

CARBURETOR ADJUSTMENT SPECIFICATIONS (NOTE 1)					
Engine Model	**MCM 120**	**MCM 140**	**MCM 165**	**MIE/MCM 470 MCM 485**	**MCM 898**
Carburetor Number	7044182 17059054 17081060	7043184 17059052 17081060	7043183 17059050	17057132	17057139 17080350
Float Level (Note 2)	5/8 (15.9)	5/8 (15.9)	5/8 (15.9)	11/16 (Note 3) (17.5)	5/8 (15.9)
Float Drop (Note 2)	1-7/16 (36.5)	1-7/16 (36.5)	1-7/16 (36.5)	1-7/16 (36.5)	1-7/16 (36.5)
Pump Rod	7/8 (22.2)	7/8 (22.2)	15/16 (23.8)	1-5/32 (29.4)	1-5/32 (29.4)
Choke Setting	Index Marks Aligned	Index Marks Aligned	Index Marks Aligned	Index Marks Aligned	Index Marks Aligned
Choke Unloader	.080 (2)	.080 (2)	.080 (2)	.080 (2)	.080 (2)
Idle Mixture Screws Preliminary Setting	1-1/4 Turns	1-1/4 Turns	1-1/4 Turns	1-1/4 Turns	1-1/4 Turns
Float Weight (grams)	10.81 g Max.	10.81 g Max.	10.81 g Max.	10.81 g Max.	10.81 g Max.

NOTES 1. All measurements are ± 1/64" (.4mm). Information contained in this chart supercedes all Service Bulletins printed from 1978 thru 1984.
2. Measure from gasket to parting line on float.
3. Fuel inlet needle is spring loaded. Before checking, raise float and allow to fall by itself. DO NOT FORCE downward by hand.

DESCRIPTION

The 2GC is a 2-bore Rochester carburetor with an automatic choke. The last letter (in model type, "C" in this case), designats type of choke on carburetor, NOT bore size. Early model 2GC carburetors had a manifold heated choke element (via stove pipe), while all later models use an electric heat choke element. The major portion of calibrated metering parts are contained in the venturi cluster (located in the float bowl) and may be serviced easily by removing the air horn assembly. Idle tubes and main discharge nozzles are pressed into venturi clusters and need not be serviced separately. Pump jets are part of venturi cluster also. Power restrictions are pressed into fuel bowl at factory, making replacement unnecessary. The primary jets and power valve assemblies are replaceable.

PRECAUTIONS

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

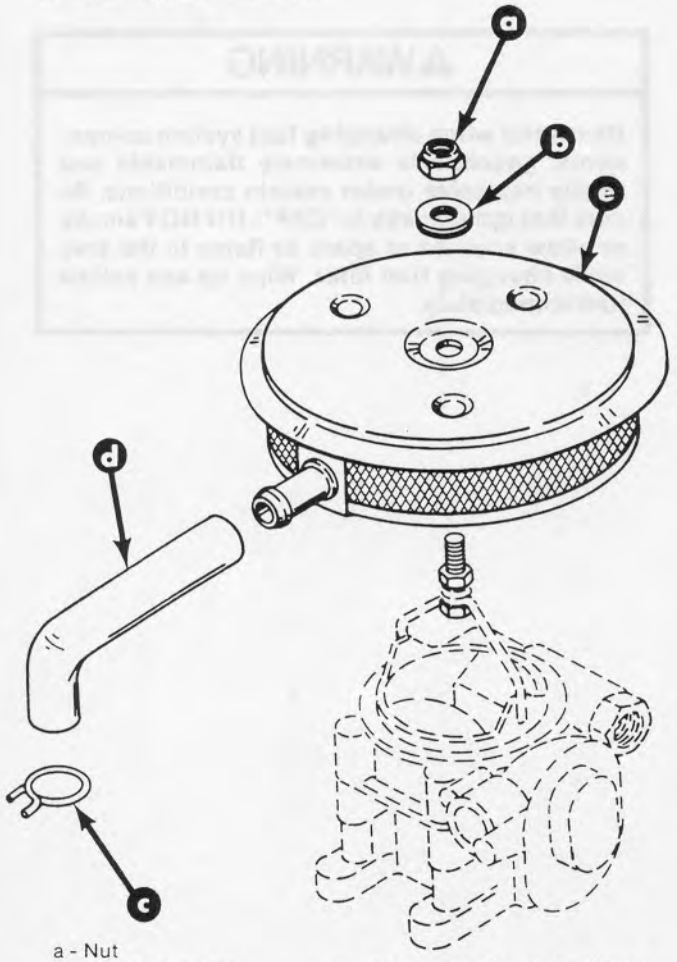
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

MAINTENANCE

FLAME ARRESTOR

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove in the following order: (Figure 1)
   a. Nut.
   b. Sealing washer.
   c. Hose clamp and crankcase ventilation hose - from flame arrestor and rocker arm cover.
   d. Flame arrestor - lift from carburetor.
2. Clean and inspect: (Figure 1)
   a. Clean flame arrestor by blowing it out with compressed air.
   b. Clean crankcase ventilation hose.
   c. Inspect crankcase ventilation hose for cracks or deterioration, replace if necessary.
3. Install in the following order: (Figure 1)
   a. Flame arrestor - place on carburetor.
   b. Crankcase ventilation hose and clamp - to flame arrestor and rocker arm cover.
   c. Sealing washer.
   d. Nut - tighten securely.



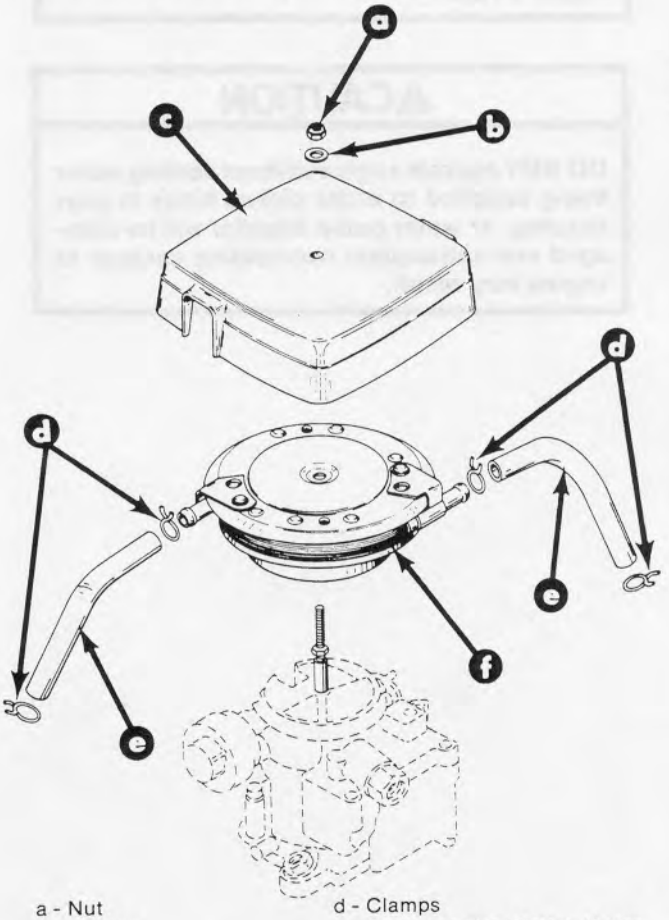
a - Nut
b - Sealing Washer
c - Hose Clamp
d - Crankcase Ventilation Hose
e - Flame Arrestor

Figure 1. Cleaning Flame Arrestor and Crankcase Ventilation Hose

FLAME ARRESTOR with CARBURETOR COVER

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove in the following order: (Figure 2)
   a. Nut.
   b. Sealing washer.
   c. Carburetor cover.
   d. Hose clamps and crankcase ventilation hoses - from flame arrestor and rocker arm covers.
   e. Flame arrestor - lift from carburetor.
2. Clean and inspect: (Figure 2)
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.
3. Install in the following order: (Figure 2)
   a. Flame arrestor - place on carburetor.
   b. Crankcase ventilation hoses and hose clamps - to flame arrestor and rocker arm covers.
   c. Carburetor cover.
   d. Sealing washer.
   e. Nut - tighten securely.



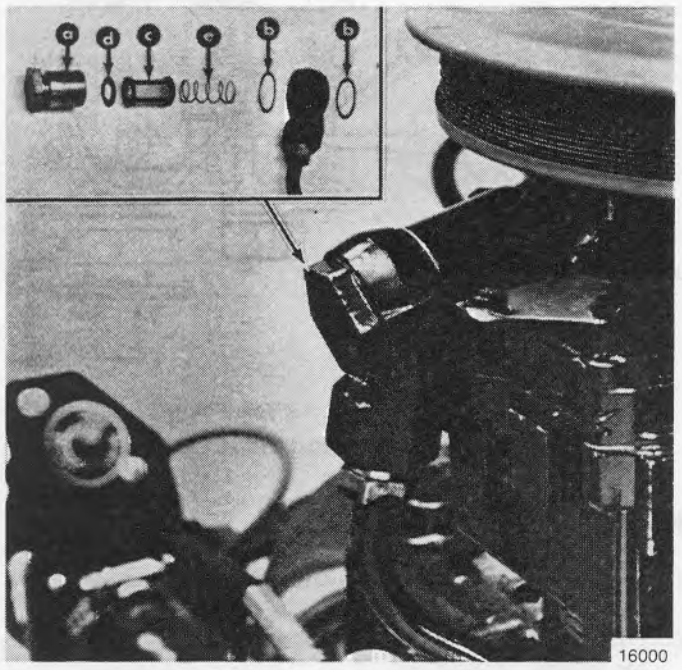
a - Nut
b - Washer
c - Carburetor Cover
d - Clamps
e - Crankcase Ventilation Hoses
f - Flame Arrestor

Figure 2. Flame Arrestor with Carburetor Cover

FUEL INLET FILTER

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

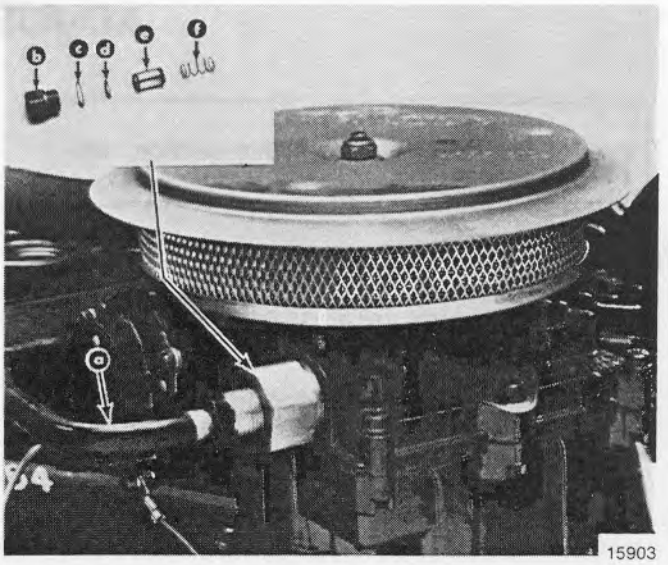
Determine which type of fuel line to carburetor connector you are servicing (Figure 3 or 4). Follow proper sequence.



a - "Banjo" Fitting Connecting Bolt
b - Gaskets
c - Filter
d - Gasket
e - Spring

Figure 3. "Banjo" Fitting Fuel Connector (470/485)

1. Remove in the following order: (Figure 3)
   a. "Banjo" fitting connecting bolt.
   b. Two large OD gaskets.
   c. Filter.
   d. Small gasket.
   e. Spring.
2. Clean:
   a. Connecting bolt and spring in solvent - dry with compressed air.
3. Install (in the following order):
   a. New small gasket - place inside bolt.
   b. New filter - open end to bottom of bolt over gasket.
   c. Spring - inside carburetor cavity.
   d. Two new large OD gaskets - one on each side of bolt.
   e. "Banjo" fitting connecting bolt - insert into carburetor, while holding components in position. Torque to specifications. Be careful not to pinch gasket.
4. Inspect:
   a. Start and run engine.
   b. Check fuel line connections for gasoline leaks.



a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket
d - Gasket
e - Filter
f - Spring

Figure 4. Filter Nut Fuel Connector

1. Remove in the following order: (Figure 4)
   a. Fuel line - from nut.
   b. Fuel inlet filter nut.
   c. Gaskets.
   d. Filter.
   e. Spring.
2. Clean:
   a. Filter nut and spring in solvent - dry with compressed air.
3. Install (in the following order):
   a. Spring.
   b. Filter - open end to filter nut.
   c. Gaskets - note sizes and location.
   d. Fuel inlet filter nut - Torque to specifications.
   e. Fuel line - Torque to specifications.
4. Inspect:
   a. Start and run engine.
   b. Check fuel line connections for gasoline leaks.

CHOKE INSPECTION

The choke does not require any periodic maintenance; however, if a choke malfunction is suspected, the following should be done:

1. With engine off, remove flame arrestor.
2. Open and close choke several times, and check for binding, loose or disconnected linkages, or other signs of damage.
3. If choke or linkage binds, sticks, or works sluggishly, clean with carburetor choke cleaner. Carefully follow directions on can.

ADJUSTMENTS

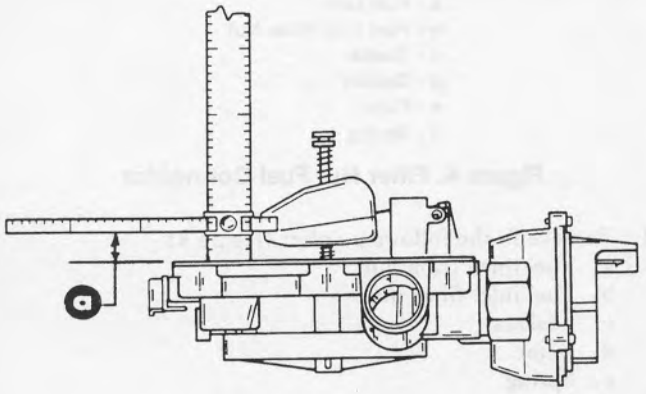
NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

FLOAT LEVEL

1. Turn air horn upside down. Pivot float assembly up and down on hinge pin to ensure it moves freely.

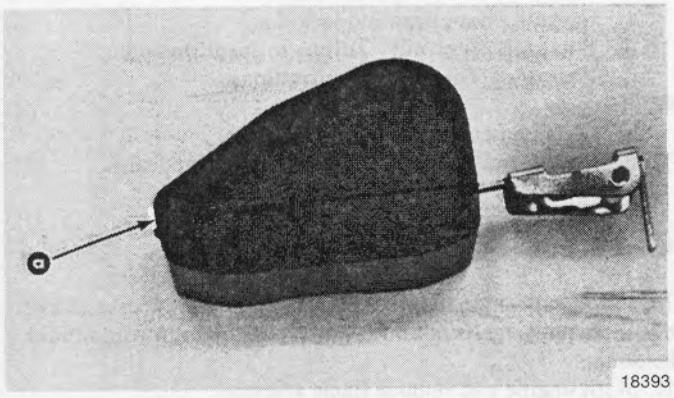
   IMPORTANT: Before checking float level, raise float and allow it to fall; however, DO NOT FORCE DOWNWARD BY HAND.

2. Using Universal Carburetor Gauge, measure from gasket to toe of float. (Figure 1 and 1A)



a - See Specifications

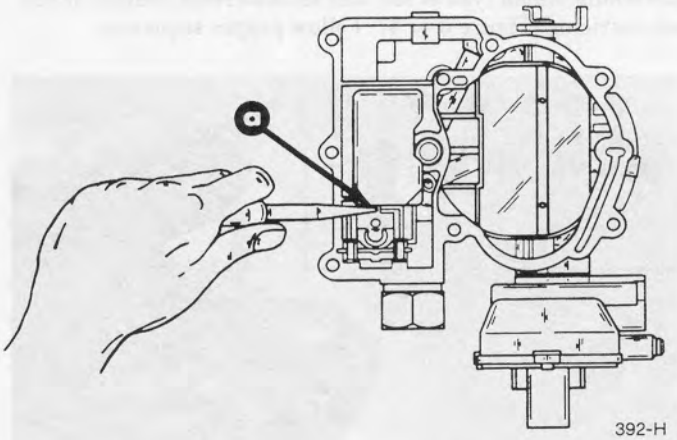
Figure 1. Measuring Float Level



a - Measure From This Point to Gasket

Figure 1A. Float Parting Line

3. Bend float arm up or down at point shown in Figure 2, to obtain specified dimension.
4. Visually check float alignment after adjustment.

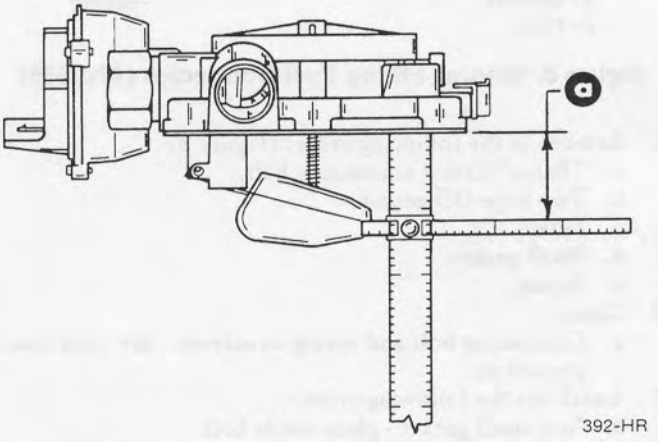


a - Bend Float Arm at This Point

Figure 2. Adjusting Float Level

FLOAT DROP

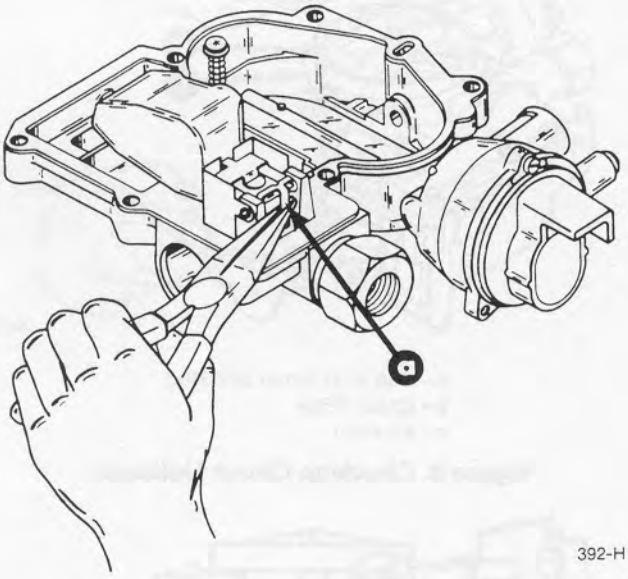
1. Hold air horn right-side-up to allow float to hang free. Air horn gasket MUST BE in place.
2. Using Universal Carburetor Gauge, measure from gasket to toe of float. (Figure 3)



a - See Specifications

Figure 3. Measuring Float Drop

3. Bend float assembly tang, as shown in Figure 4, to obtain specified dimension.
4. Recheck BOTH float level and float drop.

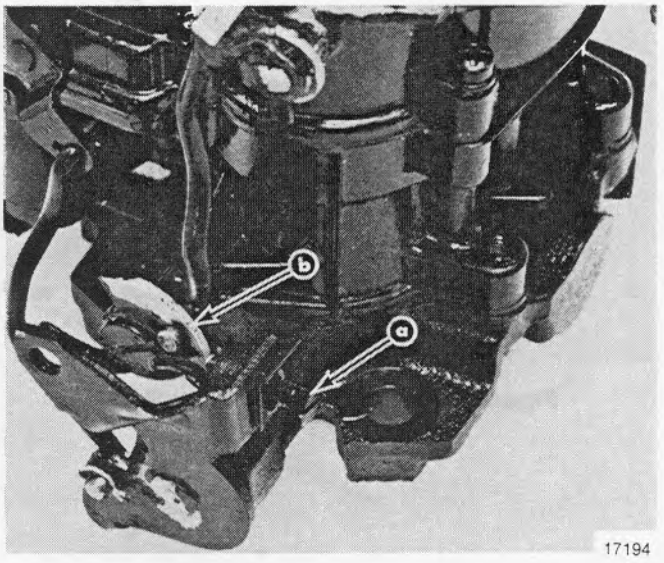


a - Float Assembly Tang

Figure 4. Adjusting Float Drop

PUMP ROD

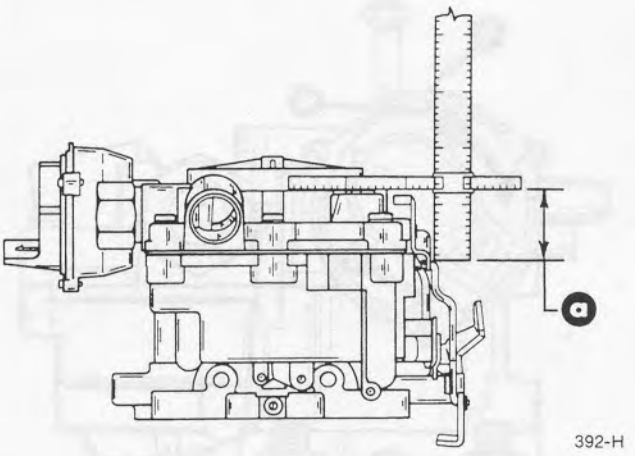
1. Back out idle speed screw until it no longer contacts idle cam. (Figure 5)



a - Idle Speed Screw
b - Idle Cam

Figure 5. Backing Out Idle Speed Screw

2. With throttle valves COMPLETELY closed, measure from flame arrestor mounting surface to top of pump rod. (Figure 6)
3. Carefully bend pump rod (where shown) to obtain specified dimension. (Figure 7)



a - See Specifications

Figure 6. Measuring Pump Rod

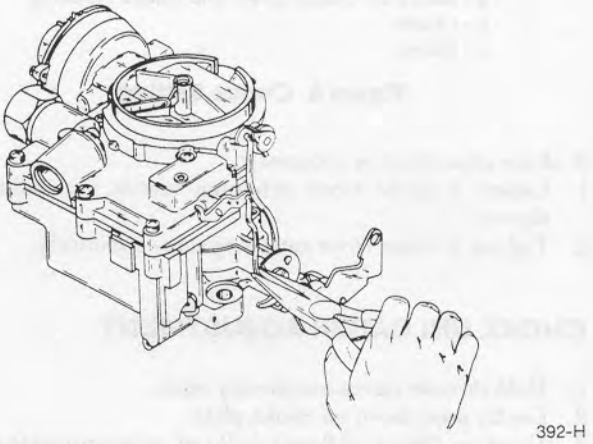
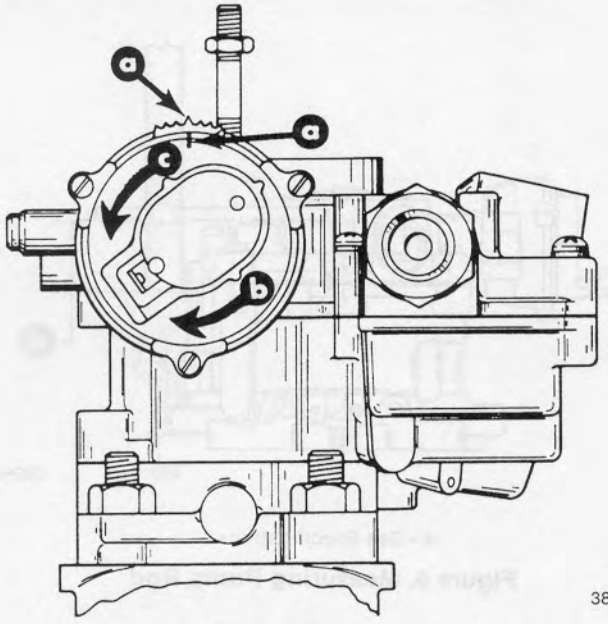


Figure 7. Adjusting Pump Rod

CHOKE SETTING

Normal choke setting is such that scribed mark on cover is in line with long case mark on choke housing. (Figure 8)



384-H

a - Marks On Choke Cover and Choke Housing
b - Leaner
c - Richer

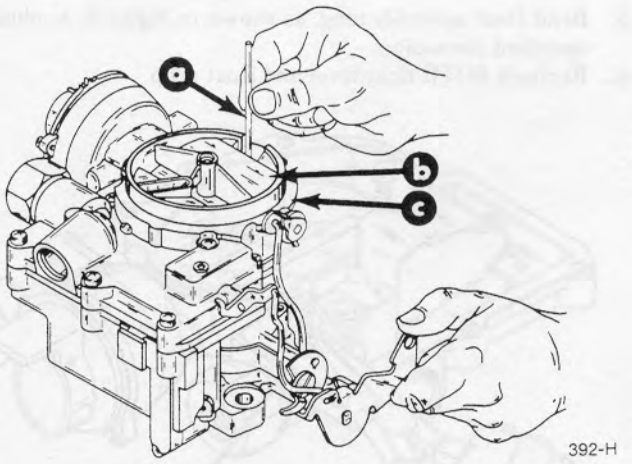
Figure 8. Choke Setting

If choke adjustment is necessary:

1. Loosen 3 choke cover retaining screws and adjust, as shown.
2. Tighten 3 choke cover retaining screws securely.

CHOKE UNLOADER ADJUSTMENT

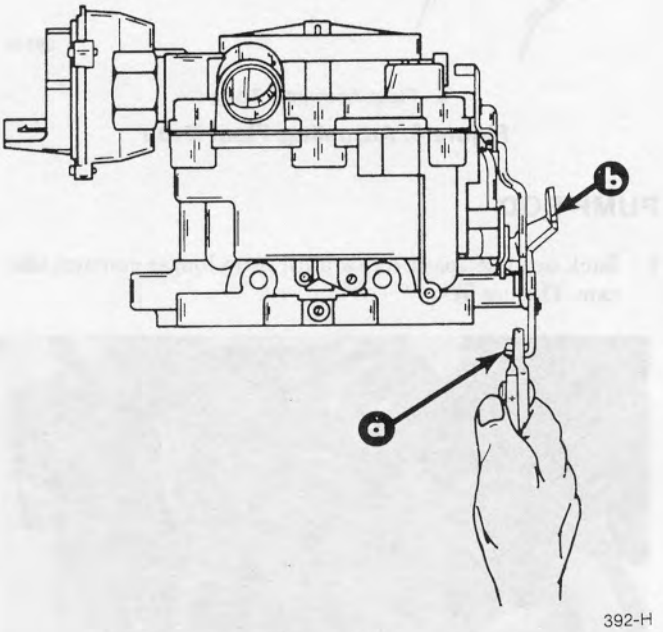
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an .080 in. (2.0mm) drill rod, or appropriate gauge, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through. (Figure 9)
4. Bend tang on throttle lever, if necessary, to obtain specified dimension. (Figure 10)



392-H

a - .080 In. (2.0mm) Drill Rod
b - Choke Plate
c - Air Horn

Figure 9. Checking Choke Unloader



392-H

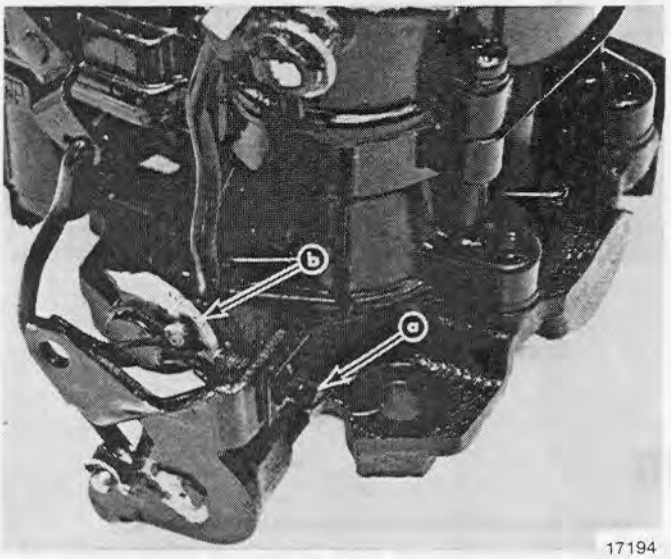
a - Tang
b - Throttle Lever

Figure 10. Adjusting Choke Unloader

PRELIMINARY IDLE SPEED and MIXTURE

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments MUST BE made with engine running.

1. Turn idle speed screw in until it just contacts idle cam; then, turn screw in an additional two turns. (Figure 11)

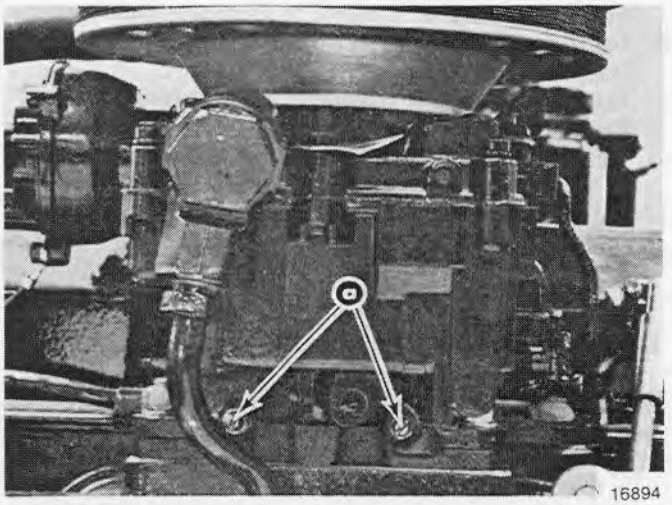


a - Idle Speed Screw
b - Idle Cam

Figure 11. Idle Speed Screw

IMPORTANT: DO NOT turn idle mixture needles tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needles in until they LIGHTLY SEAT; then, back needle out 1¼ turns. (Figure 12)



a - Two Idle Mixture Screws

Figure 12. Idle Mixture Adjustment

FINAL IDLE SPEED and MIXTURE

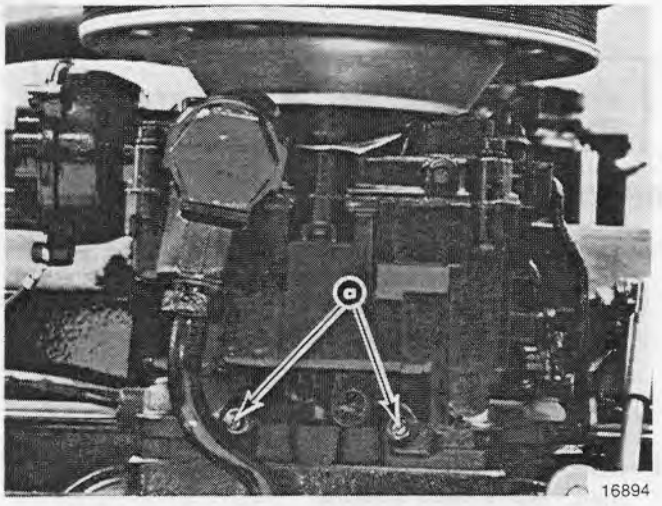
IMPORTANT: Boat MUST BE in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under "Specifications", with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needles (Figure 1) tightly into seat, as damage to needle and/or seat may result.



a - Two Idle Mixture Needles

Figure 1. Idle Mixture Needle Location

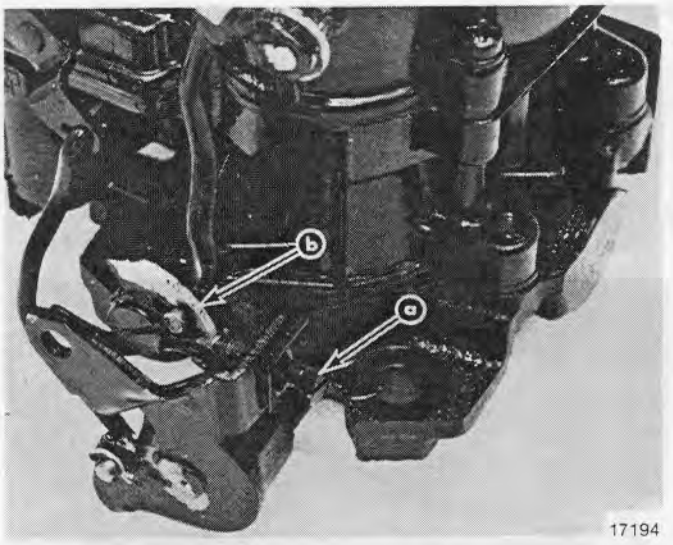
2. If a new or rebuilt carburetor has been installed, turn each idle mixture needle (Figure 1) in (clockwise) until it LIGHTLY contacts seat; then, back out needle 1¼ turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

DO NOT leave the helm unoccupied while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable brass barrel from anchor stud. BE SURE NOT TO LOSE SPACER ON ANCHOR STUD.
6. Adjust idle speed adjustment screw (Figure 2) to obtain specified RPM.
7. With engine running at specified RPM, adjust idle mixture needles (Figure 1), as follows:
   a. Turn idle mixture needle inward (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw outward (counterclockwise) until the speed begins to drop due to a rich mixture.
   c. Turn screw inward to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Repeat procedure with other needle.
   e. Readjust idle speed adjusting screw, if necessary, to obtain specified RPM.

IMPORTANT: Refer to "Section 2 (Removal, Installation, and Alignment)" for throttle cable installation and adjustment.



a - Idle Speed Adjustment Screw

Figure 2. Idle Speed Adjusting Screw

REPAIR

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

REMOVAL

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may then be inspected for contamination as carburetor is disassembled.

1. Remove crankcase ventilation hose from flame arrestor; then, remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove swivel link assembly from carburetor.
5. Remove fuel line.
6. Remove fuel pump sight tube from carburetor.
7. Disconnect choke.
8. Remove carburetor attaching nuts and washers and remove carburetor.
9. Remove and discard gaskets.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

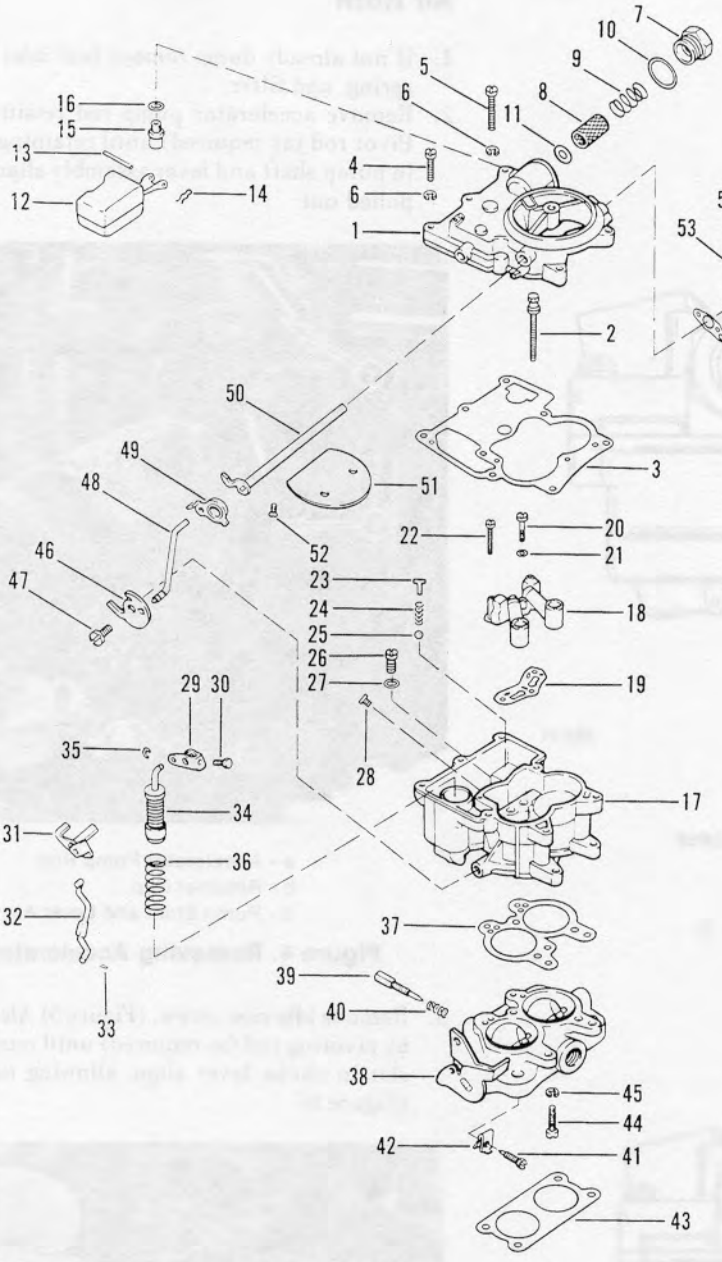
INSTALLATION

1. Thoroughly clean gasket surfaces. Use care to prevent gasket material from entering intake manifold.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to specifications.
3. Connect fuel line to fuel inlet nut and torque to specifications.
4. Connect fuel pump sight tube to fitting on carburetor.
5. Reconnect choke.
6. Check to ensure that 8-12 threads of link rod are exposed from swivel; then, attach swivel link assembly to throttle lever, using nut and washer.
7. Move intermediate throttle lever back-and-forth and check for binding in throttle linkage. If binding occurs, remove swivel link assembly from throttle lever and adjust link (by turning link rod), as required, to eliminate binding.
8. Install throttle cable, as explained, in "Section 2 (Removal, Installation, and Alignment)".
9. Install flame arrestor and crankcase ventilation hose.
10. Reconnect battery cables to battery.
11. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
12. Adjust idle speed and idle mixture, as outlined under "Adjustments", preceding.

DISASSEMBLY

The following is a step-by-step procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessary steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

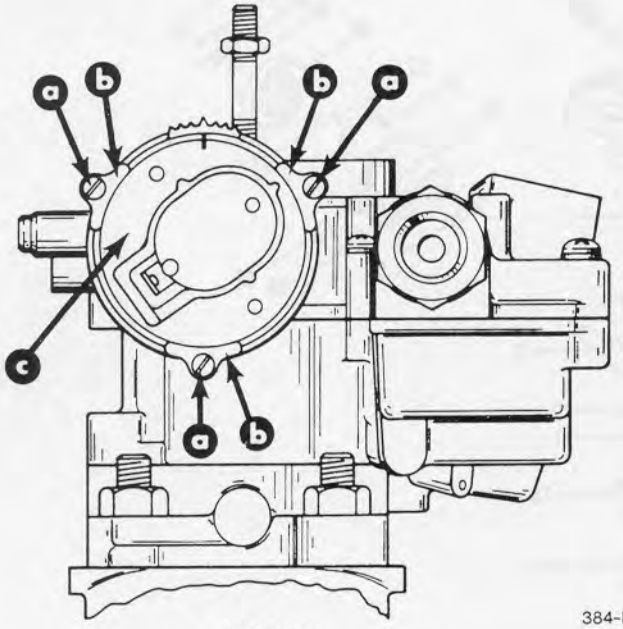


1 - AIR HORN
2 - POWER PISTON ASSEMBLY
3 - GASKET
4 - SCREW
5 - SCREW
6 - LOCKWASHER
7 - NUT
8 - FILTER
9 - SPRING
10 - GASKET
11 - GASKET
12 - FLOAT ASSEMBLY
13 - PIN
14 - CLIP
15 - INLET NEEDLE and SEAT ASSEMBLY
16 - GASKET
17 - FLOAT BOWL ASSEMBLY
18 - VENTURI CLUSTER ASSEMBLY
19 - GASKET
20 - SCREW
21 - GASKET
22 - SCREW
23 - GUIDE
24 - SPRING
25 - BALL
26 - POWER VALVE ASSEMBLY
27 - GASKET
28 - JET
29 - LEVER
30 - SCREW
31 - PUMP SHAFT and LEVER ASS'Y
32 - ROD
33 - CLIP
34 - PUMP ASSEMBLY
35 - CLIP
36 - SPRING
37 - GASKET
38 - THROTTLE BODY ASSEMBLY
39 - IDLE ADJUSTING NEEDLE
40 - SPRING
41 - IDLE STOP SCREW
42 - CLIP
43 - GASKET
44 - SCREW
45 - LOCKWASHER
46 - CAM
47 - SCREW
48 - ROD
49 - CHOKE LEVER and COLLAR ASSEMBLY
50 - CHOKE SHAFT ASSEMBLY
51 - VALVE
52 - SCREW
53 - CHOKE HOUSING ASSEMBLY
54 - GASKET
55 - SCREW
56 - LEVER ASSEMBLY
57 - SCREW
58 - WELCH PLUG — Electric Choke Models Only
59 - PLUG — Electric Choke Models Only
60 - COVER
61 - SCREW
62 - LOCKWASHER
63 - TERMINAL — Electric Choke Models Only
64 - RETAINER

Figure 1. Rochester Two-Barrel

Choke Housing Assembly

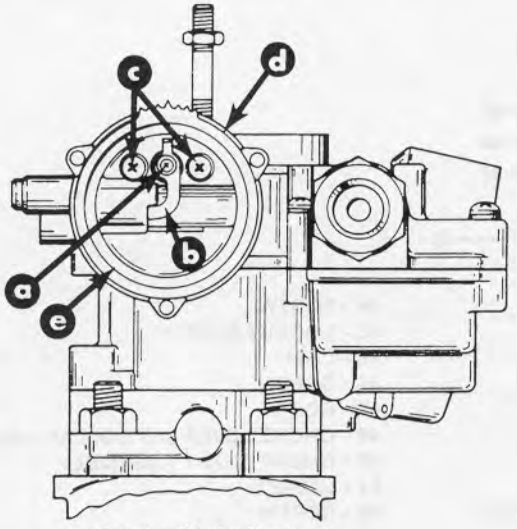
1. Remove choke cover. (Figure 2)



a - Screws
b - Retainers
c - Choke Cover

Figure 2. Removing Choke Cover

2. Remove choke lever. (Figure 3)
3. Remove choke housing assembly. (Figure 3)

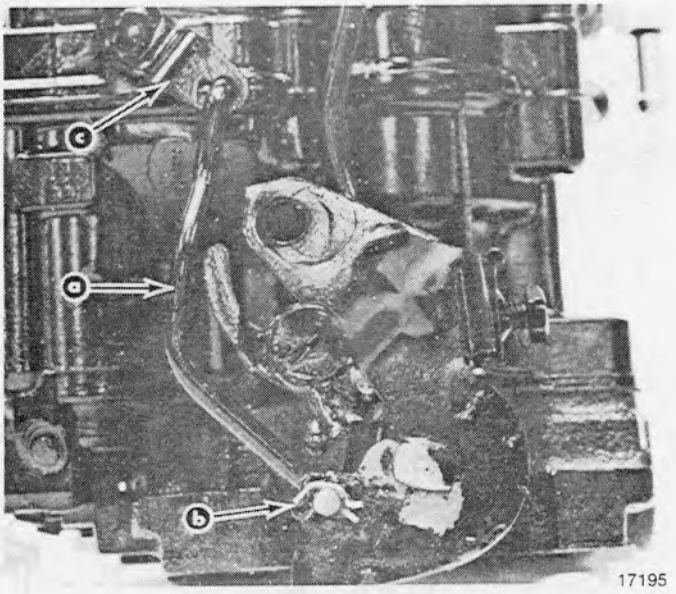


a - Screw - Choke Lever
b - Choke Lever
c - Screws - Choke Housing Assembly
d - Gasket
e - Choke Housing Assembly

Figure 3. Removing Choke Lever and Choke Housing Assembly

Air Horn

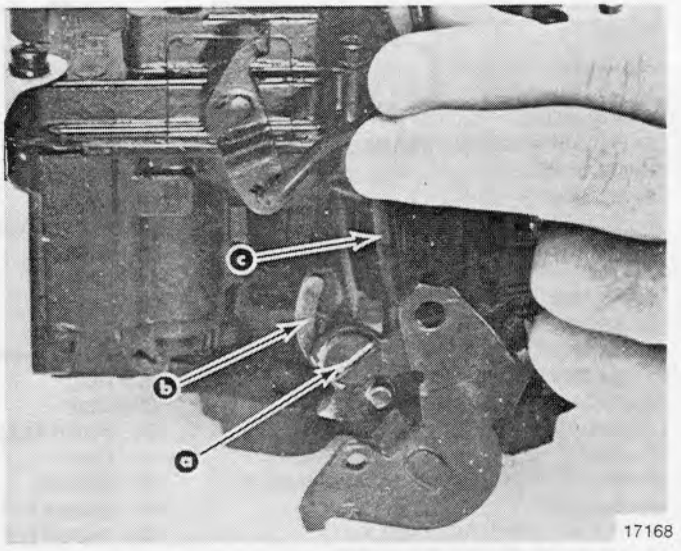
1. If not already done, remove fuel inlet filter nut, washers, spring, and filter.
2. Remove accelerator pump rod retaining clip. (Figure 4) Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever Assembly

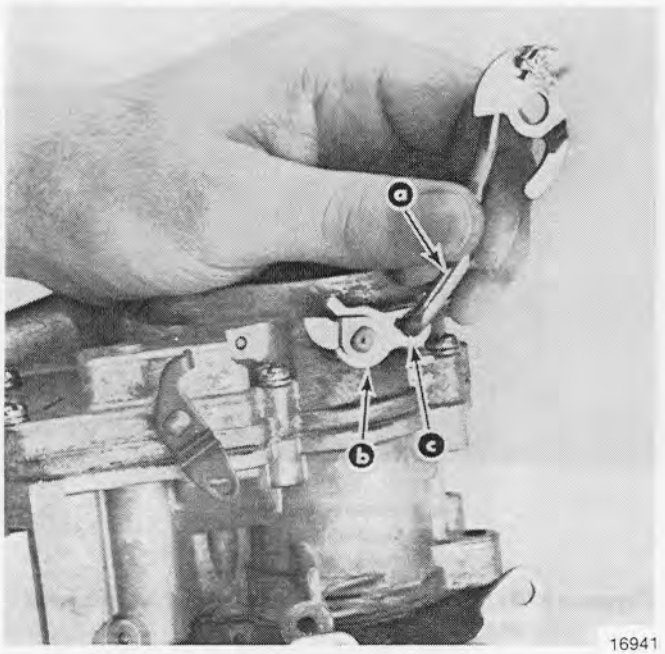
Figure 4. Removing Accelerator Pump Rod

3. Remove idle cam screw. (Figure 5) Also, remove choke rod by pivoting rod (as required) until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out. (Figure 6)



a - Idle Cam Screw b - Idle Cam c - Choke Rod

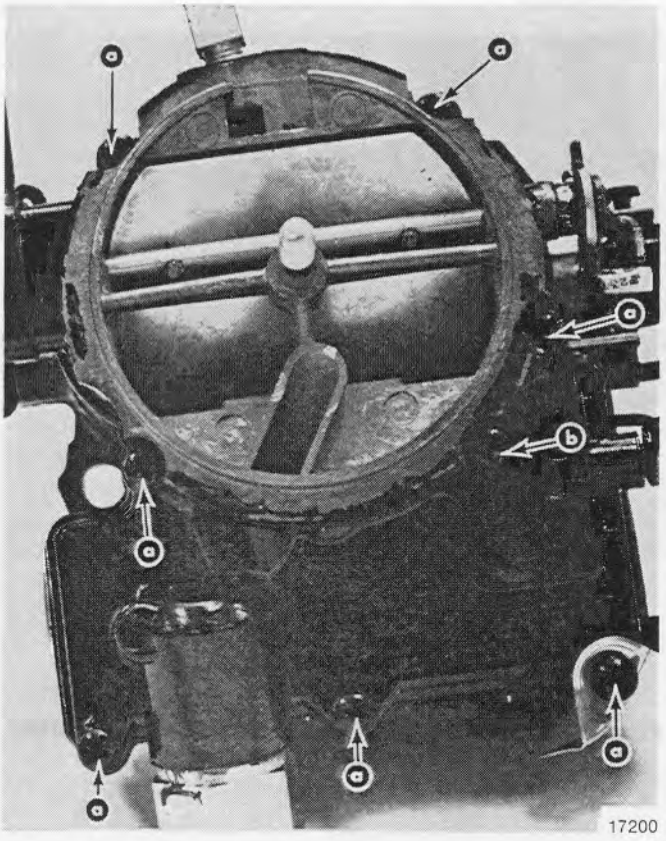
Figure 5. Removing Idle Cam



a - Choke Rod
b - Choke Lever
c - Slot

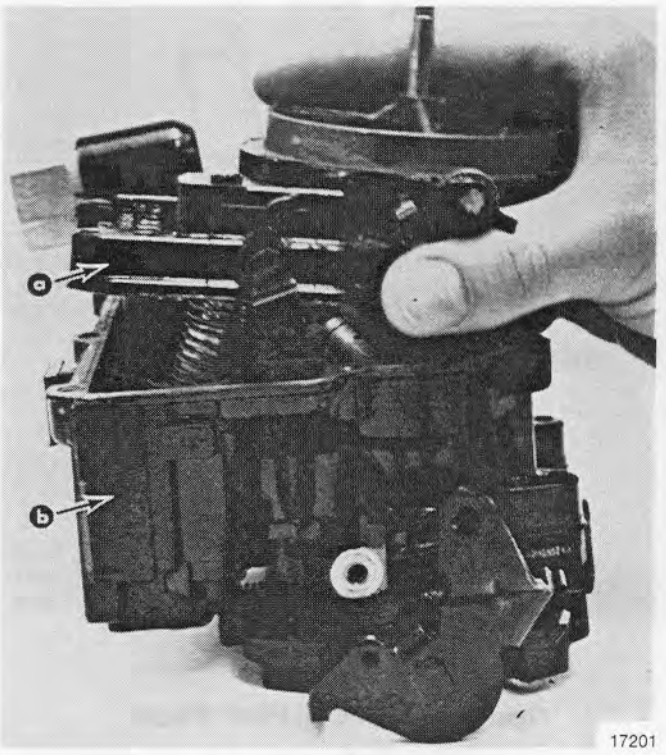
Figure 6. Removing Choke Rod

4. Remove air horn as shown in Figures 7 and 8.



a - Air Horn Attaching Screws (7 Short)
b - Air Horn Attaching Screws (Long)

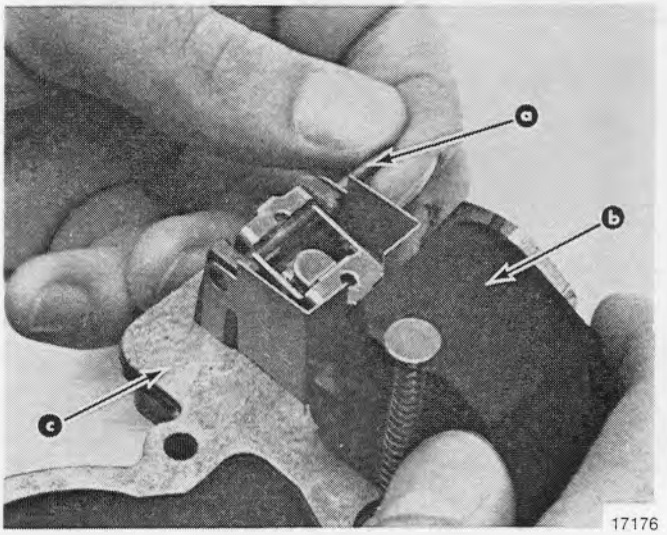
Figure 7. Air Horn Attaching Screw Location



a - Air Horn - Carefully Lift Off
b - Float Bowl Assembly

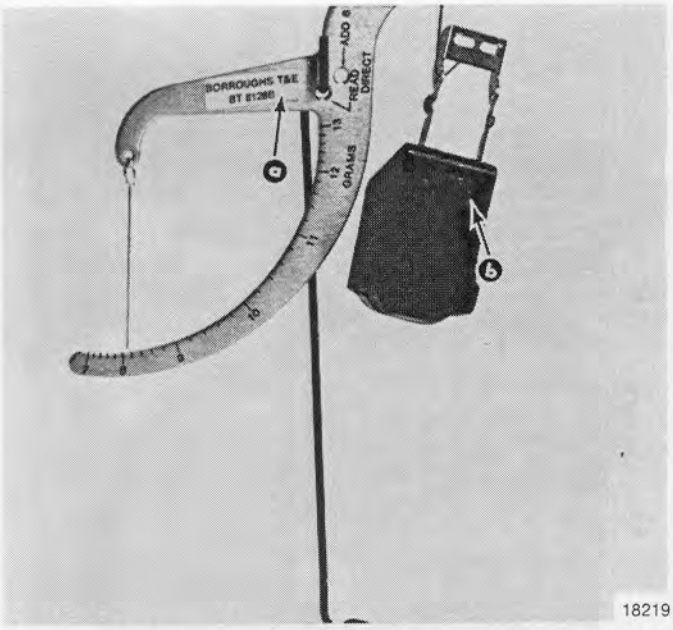
Figure 8. Carefully Removing Air Horn

5. Invert air horn and carefully lay on bench.
6. Remove float hinge pin and lift float assembly from air horn. (Figure 9) Check float weight as shown in Figure 9A.
7. Remove air horn gasket. (Figure 9)



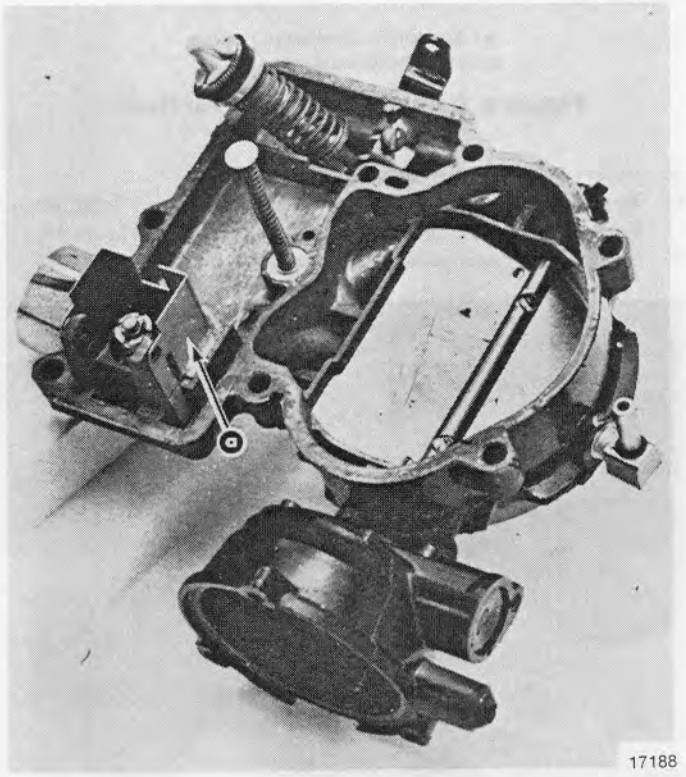
a - Float Hinge Pin
b - Float Assembly
c - Air Horn Gasket

Figure 9. Removing Float Assembly and Air Horn Gasket



a - Grams Scale
b - Float

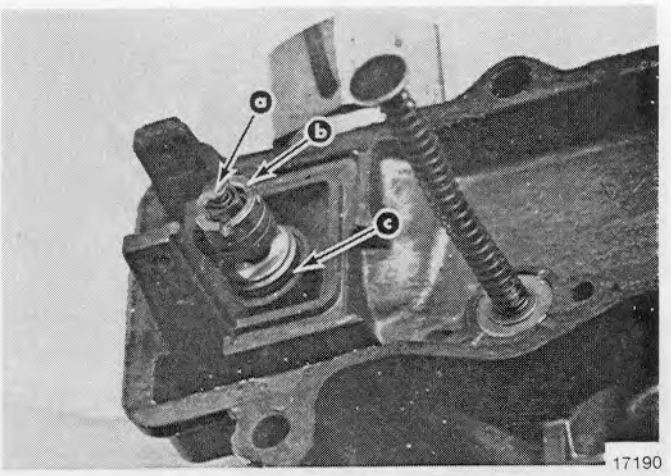
Figure 9A. Checking Float Weight



a - Baffle

Figure 10. Removing Baffle

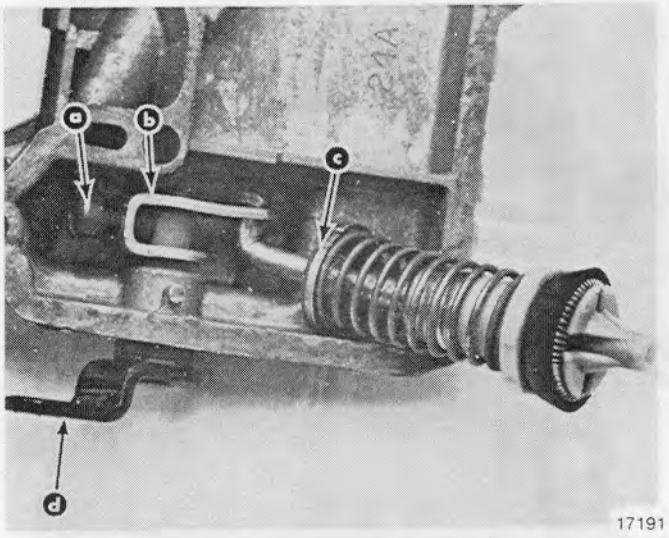
8. Remove baffle. (Figure 10)
9. Remove needle assembly. (Figure 11)
10. Remove needle seat and gasket. (Figure 11)



a - Needle Assembly
b - Needle Seat
c - Gasket

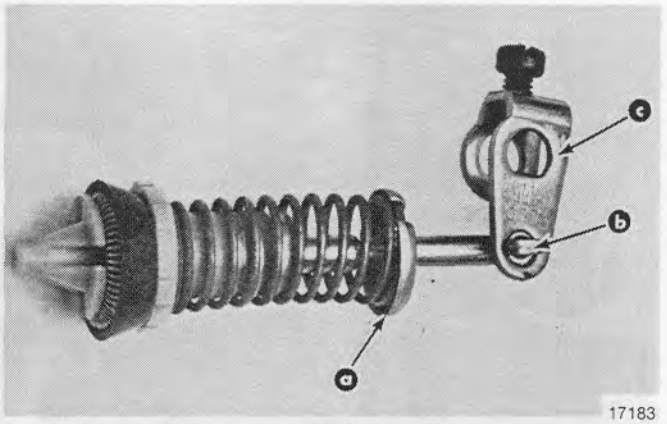
Figure 11. Removing Needle Assembly, Needle Seat and Gasket

11. Loosen accelerator pump screw. Slide pump shaft and lever assembly (and washer) out of air horn; then, remove accelerator pump assembly and pump lever. (Figure 12)
12. To remove accelerator pump from pump lever, cut off swedged end of pump rod. (Figure 13) Replacement accelerator pump will have a groove and retainer clip for reinstallation.



a - Accelerator Pump Screw
b - Pump Shaft and Lever Assembly
c - Accelerator Pump Assembly
d - Pump Lever

Figure 12. Removing Pump Shaft and Lever Assembly and Accelerator Pump Assembly

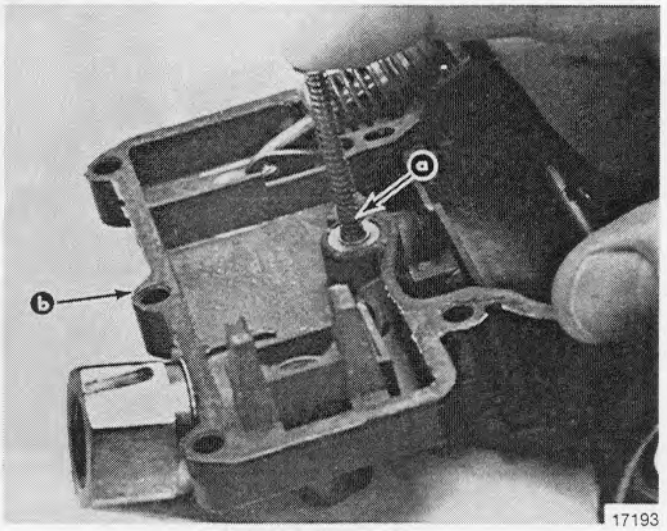


a - Accelerator Pump Assembly
b - Swedge - Cut Off
c - Pump Shaft and Lever Assembly

Figure 13. Removing Accelerator Pump Assembly

IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

13. To remove the power piston, push up and down against piston spring until piston comes loose from air horn. (Figure 13A)

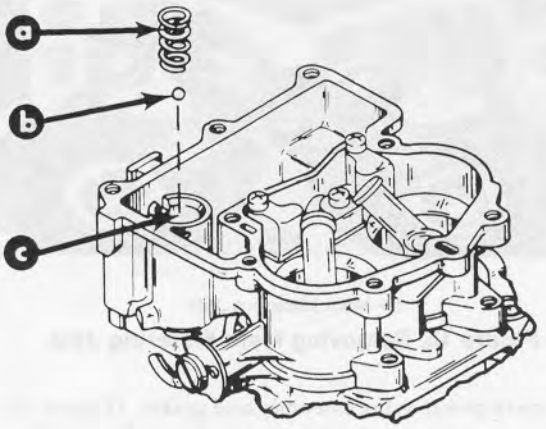


a - Power Piston
b - Air Horn

Figure 13A. Removing Power Piston

Float Bowl Assembly

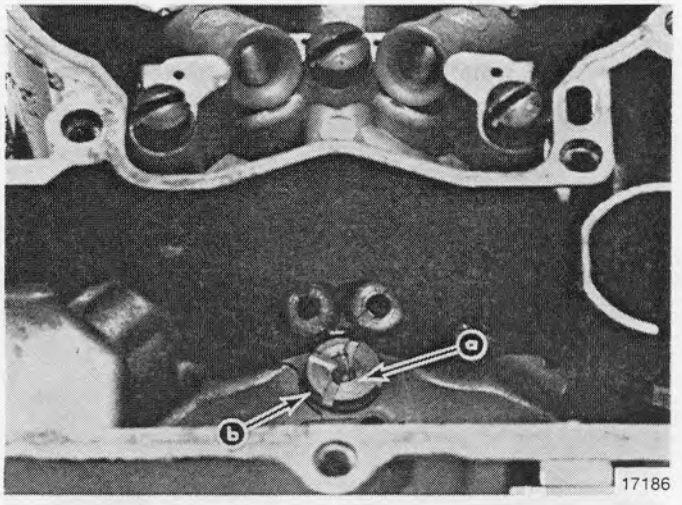
1. Remove accelerator pump return spring from pump well. (Figure 14)
2. Remove check ball (if equipped) from pump well. (Figure 14)



a - Return Spring
b - Refer to "IMPORTANT" following
c - Pump Well

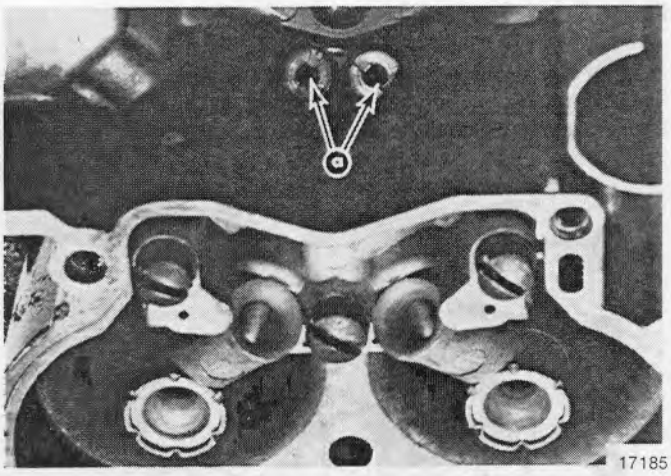
Figure 14. Removing Accelerator Pump Return Spring and Check Ball

IMPORTANT: Later model carburetors do not use a check ball.



a - Power Valve Assembly
b - Gasket

Figure 15. Removing Power Valve Assembly



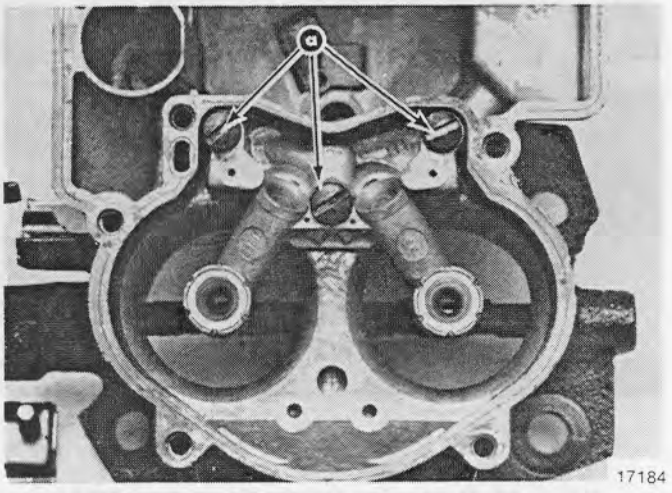
a - Main Metering Jets

Figure 16. Removing Main Metering Jets

3. Remove power valve assembly and gasket. (Figure 15)
4. Remove main metering jets and gaskets. (Figure 16)

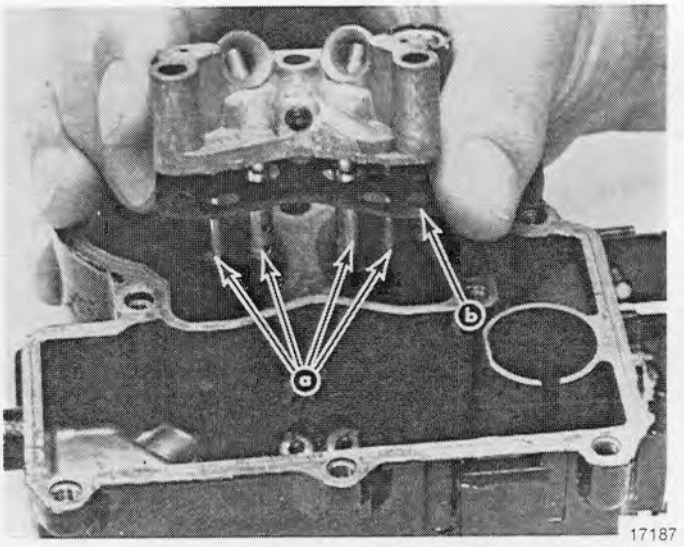
IMPORTANT: Use care when removing venturi cluster (in the following step) to prevent damaging brass tubes protruding from bottom of cluster. (Figure 18) DO NOT REMOVE TUBES. These tubes are permanently pressed into the venturi cluster and are not replaceable. Place venturi cluster upside down on a clean work bench, after removal, to minimize the risk of damage to tubes.

5. Remove three venturi cluster screws (Figure 17), and carefully remove cluster and venturi gasket. (Figure 18)



a - Screws and Lockwashers

Figure 17. Removing Venturi Cluster Attaching Screws



a - Venturi Cluster Brass Tubes
b - Gasket

Figure 18. Carefully Remove Venturi Clusters

6. Remove pump discharge, spring retainer, spring, and ball as shown in Figure 18A.

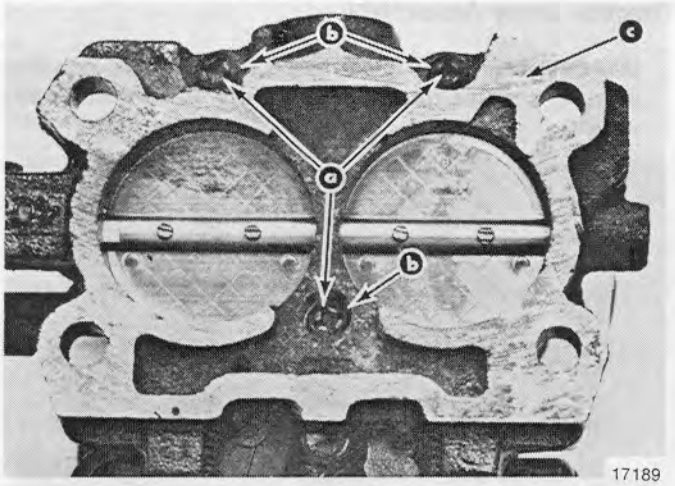
a - Spring Retainer

Figure 18A. Removing Pump Discharge Ball

Throttle Body Assembly

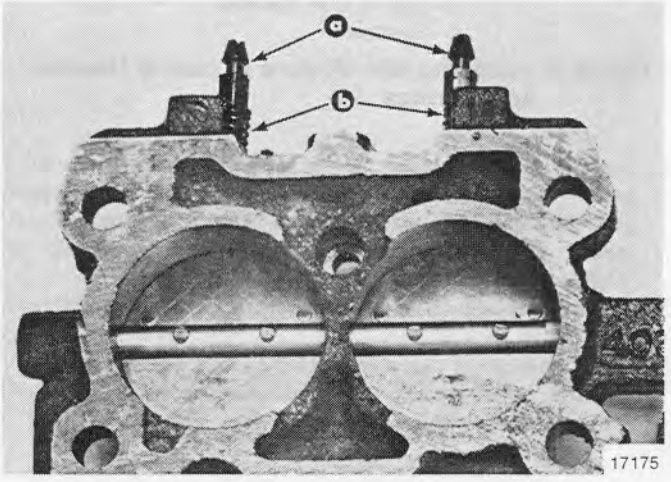
IMPORTANT: Use extreme care when handling throttle body, so as not to damage throttle valves.

1. Place float bowl assembly upside down. Remove three throttle body assembly attaching screws and lockwashers, and remove throttle body and gasket from float bowl. (Figure 19)
2. Remove idle mixture adjusting needle and spring. (Figure 20)
3. Remove idle speed screw, if replacement is necessary. (Figure 21)



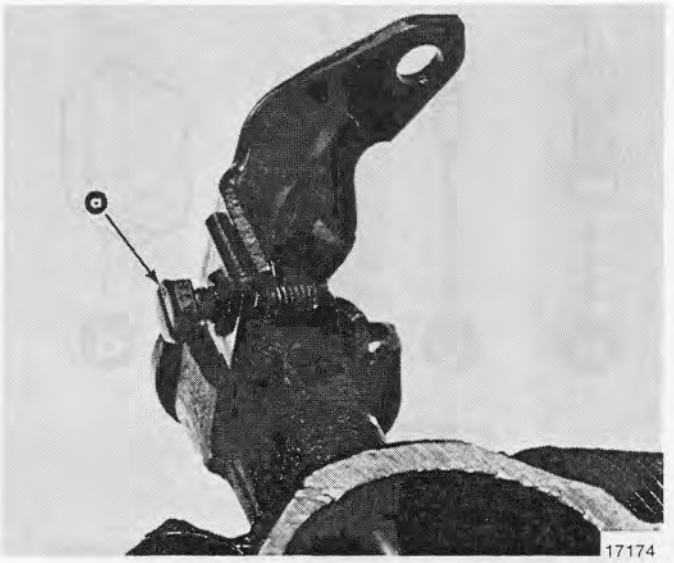
a - Screws
b - Lockwashers
c - Throttle Body - Gasket Not Seen In Photo

Figure 19. Separating Throttle Body From Float Bowl Assembly



a - Idle Mixture Adjusting Needles
b - Springs

Figure 20. Removing Idle Adjusting Needles and Springs



a - Idle Speed Screw

Figure 21. Removing Idle Speed Screw and Spring

IMPORTANT: Throttle valves have been precisely fitted to throttle body, at the factory, and should not be removed under any circumstances. If any of the remaining throttle body parts are found to be worn or damaged, complete throttle body assembly MUST BE replaced. Throttle body assembly can be cleaned in carburetor cleaner.

CLEANING and INSPECTION

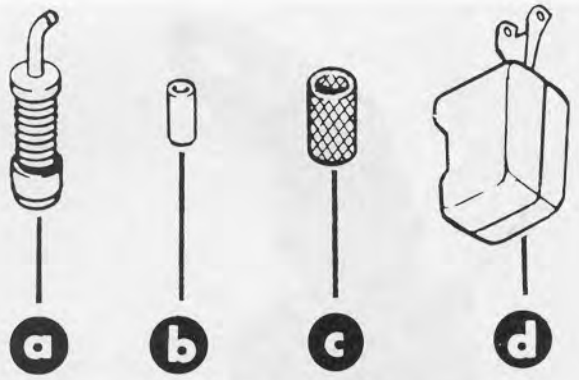
Carbon, varnish, gum, dirt, and water contaminants in the carburetor or on exterior moving parts of the carburetor often are responsible for carburetion malfunctions. Therefore, carefully observe the following cleaning and inspection procedure, to obtain effective carburetor repair.

IMPORTANT: DO NOT use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

⚠CAUTION

The float assembly, float needle, accelerator pump plunger, and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden, and/or distort.



a - Accelerator Pump
b - Needle and Seat Assembly
c - Fuel Filter
d - Float Assembly

Figure 22. Items Which MUST NOT BE Immersed In Carburetor Cleaner

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe-off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:
   a. **Float Needle and Seat:** If float needle or seat is worn or damaged, replace with a new needle and seat assembly.

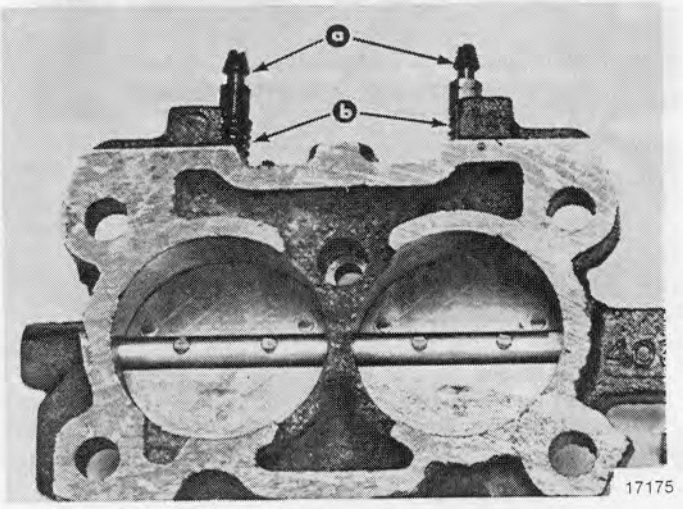
      IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

   b. **Float Assembly and Hinge Pin:** Inspect float pontoon for deterioration and porosity. Check pontoon density (to see if it is saturated with fuel), by comparing weight of float with specifications. If pontoon weight is high, float assembly MUST BE replaced. Check hinge pin and holes for wear.
   c. **Fuel and Air Passages:** Passages MUST BE perfectly clean for proper carburetor operation.
   d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring (on pump assembly) and return spring.
   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.
   f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle MUST BE replaced.
   g. **Levers and Linkages:** Check levers, links and rods for wear.
   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding thru entire operating range, making sure valve opens and closes completely. Throttle body assembly MUST BE replaced if throttle valve and shaft are worn or damaged.
   i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding thru entire operating range, making sure valve opens and closes completely. Air horn assembly MUST BE replaced if choke valve and shaft and lever assembly are worn or damaged.
   j. **Inspect casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

REASSEMBLY

Throttle Body Assembly

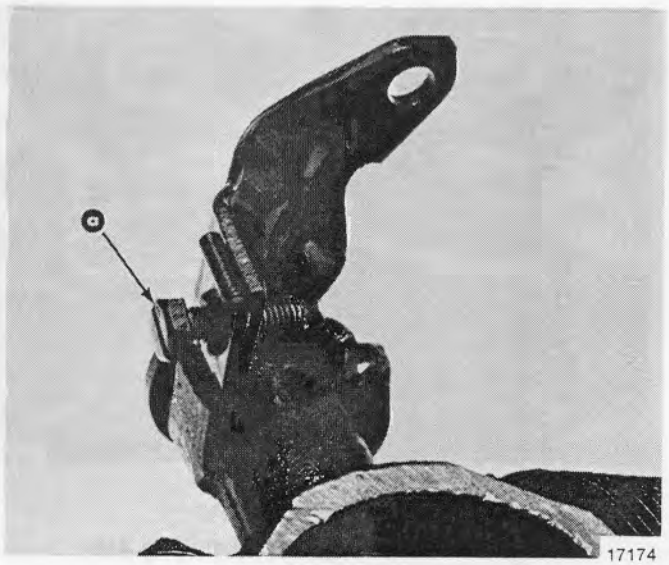
IMPORTANT: DO NOT force idle mixture needle against seat as damage to needle and/or seat will result.



a - Idle Mixture Needles
b - Springs

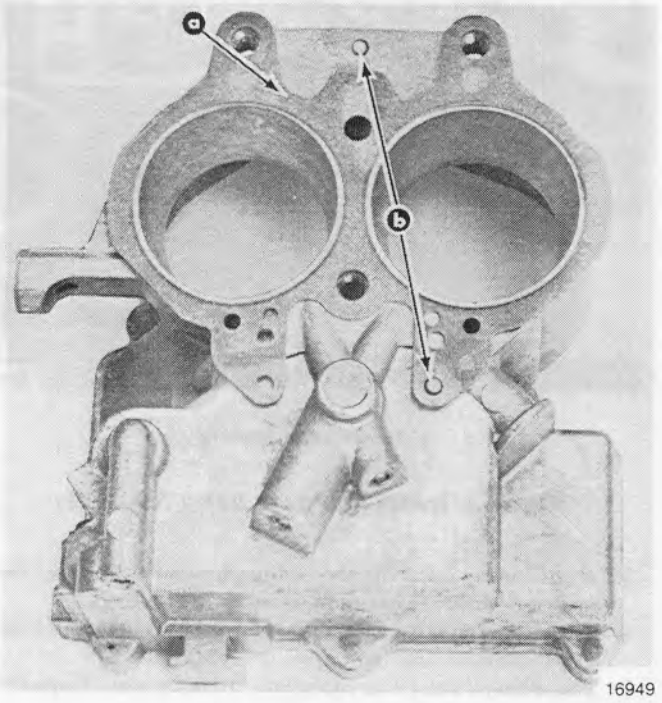
Figure 1. Installing Idle Mixture Adjusting Needles and Springs

1. Screw idle mixture needle (and spring) into throttle body until they lightly seat; then, back out needle 1¼ turns as a preliminary idle mixture setting. (Figure 1) Final adjustment will be made with engine running. (Refer to "Adjustments".)
2. Thread idle speed screw and spring into throttle lever. (Figure 2)
3. Turn float bowl assembly upside-down and place NEW throttle body gasket on bowl, making sure gasket is properly positioned on locating dowel. (Figure 3)



a - Idle Speed Screw

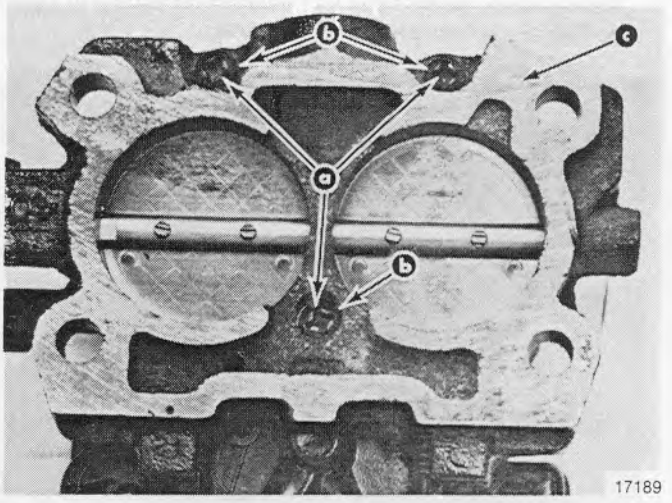
Figure 2. Installing Idle Speed Screw



a - Throttle Body Gasket
b - Locating Dowel

Figure 3. Throttle Body Gasket Properly Positioned on Float Bowl Assembly

4. Install throttle body assembly on float bowl assembly, making sure that screw holes in gasket line up with screw holes in throttle body. (Figure 4) Tighten screws evenly and securely.

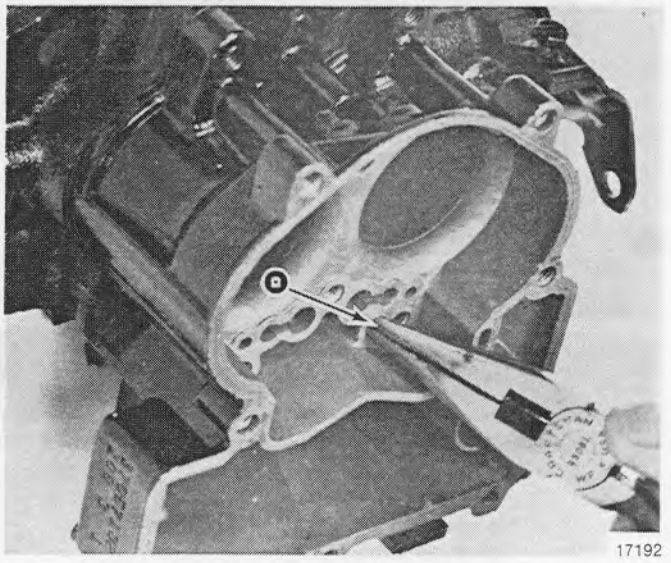


a - Screws
b - Lockwashers
c - Throttle Body Assembly

Figure 4. Installing Throttle Body Assembly on Float Bowl Assembly

Float Bowl Assembly

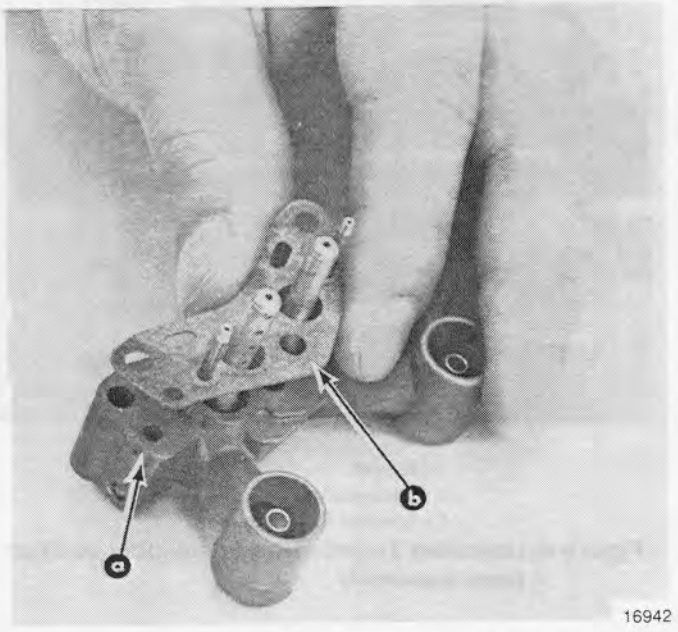
IMPORTANT: Place float bowl and throttle assemblies in a holding fixture to prevent throttle valves from being damaged.



a - Spring Retainer

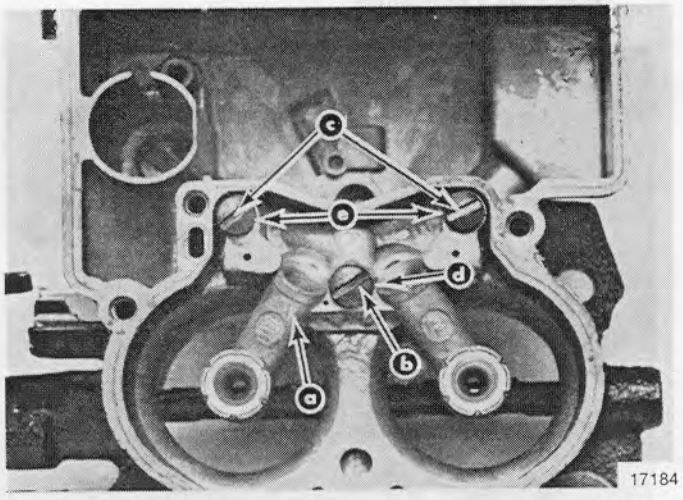
Figure 4A. Installing Pump Discharge Ball

1. Install pump discharge ball, spring, and spring retainer, as shown in Figure 4A.
2. Place new gasket over venturi cluster brass tubes. (Figure 5) Carefully install venturi cluster in float bowl, using three screws, gaskets and lockwashers, as shown in Figure 6. Tighten screws evenly and securely.



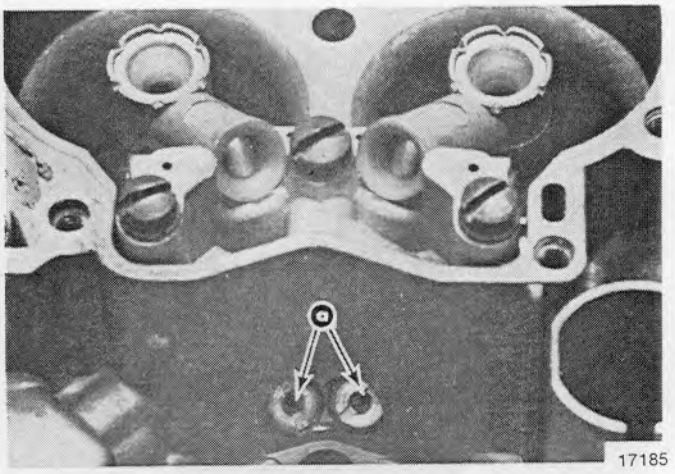
a - Venturi Cluster
b - Gasket

Figure 5. Placing Gasket on Venturi Cluster



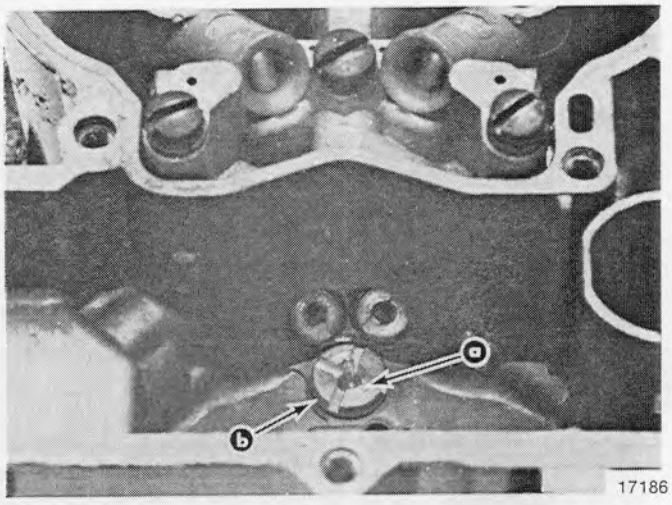
a - Venturi Cluster
b - Center Screw (with smooth shank)
c - Outer Screws
d - Fiber Washer
e - Lockwashers

Figure 6. Installing Venturi Cluster



a - Main Metering Jets

Figure 7. Installing Main Metering Jets

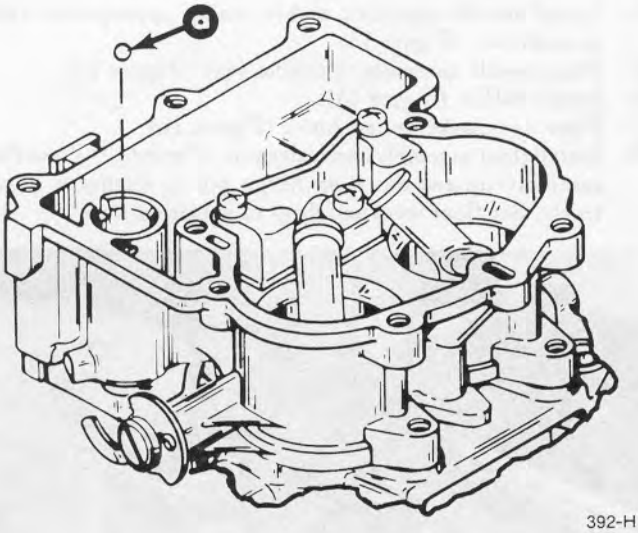


a - Power Valve Assembly
b - Gasket

Figure 8. Installing Power Valve Assembly

3. Install main metering jets and gaskets in bottom of float bowl assembly; tighten jets securely. (Figure 7)
4. Install power valve assembly and gasket in bottom of float bowl assembly and tighten securely. (Figure 8)
5. Place check ball (if so equipped) in pump well. (Figure 9)

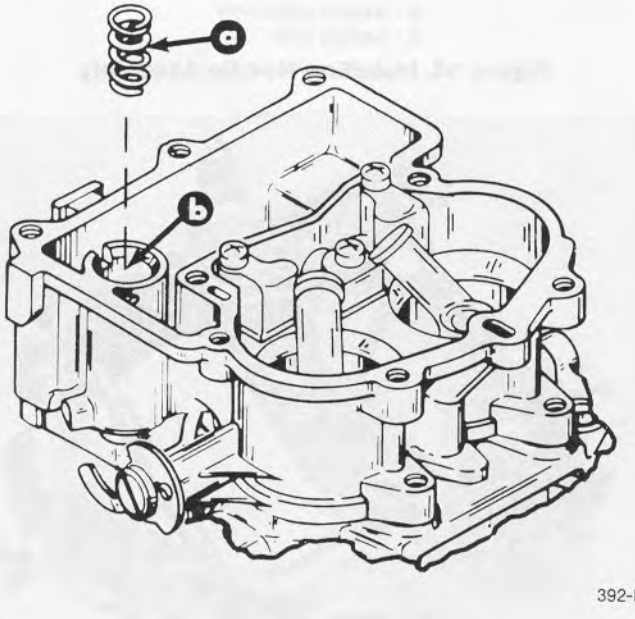
IMPORTANT: Later model carburetors do not have a check ball in accelerator pump well. Install a new check ball ONLY if carburetor had a ball in it when you took it apart.



a - Refer to "IMPORTANT" Preceding

Figure 9. Installing Check Ball, Strainer, and Retainer Clip

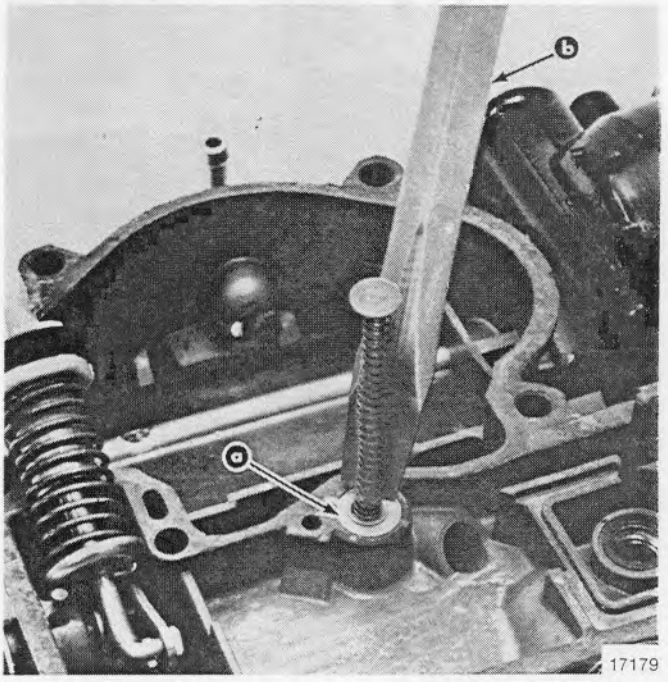
6. Place accelerator pump return spring in pump well. (Figure 10)



a - Accelerator Pump Return Spring
b - Pump Well

Figure 10. Installing Accelerator Pump

Air Horn Assembly



a - Power Piston
b - Screwdriver or Punch

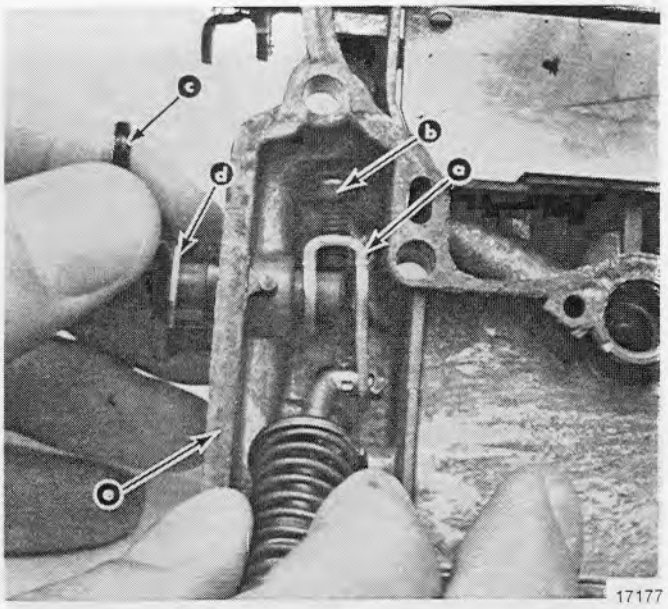
Figure 11. Installing Power Piston

1. Install power piston as shown in Figure 11.

IMPORTANT: Power piston must be fully seated in air horn casting.

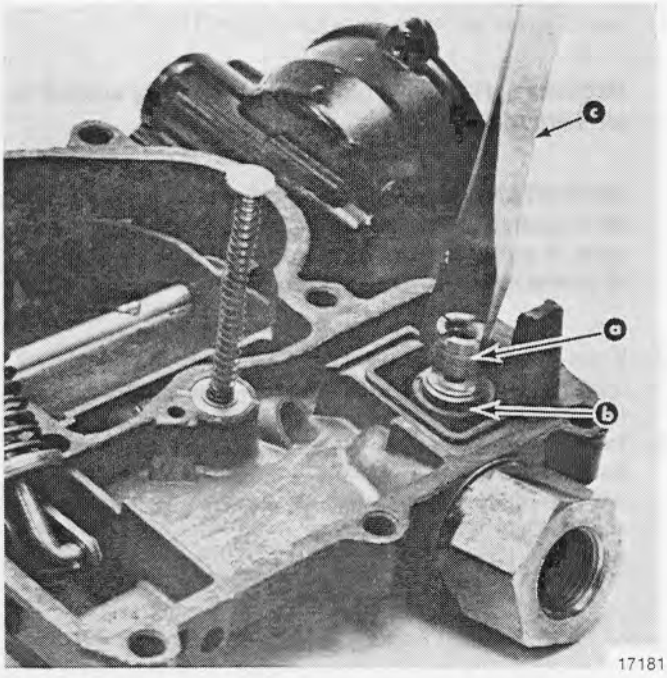
IMPORTANT: Accelerator pump assembly MUST BE installed correctly, as explained in the following step. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

2. If accelerator pump assembly was removed from pump lever, secure new pump assembly to pump lever with retainer clip.
3. Insert pump shaft and lever assembly (and washer) into air horn; then, align indexed hole in pump lever with shaft and lever assembly and slide shaft all-the-way into lever so that shoulder on shaft is hitting lever. Tighten set screw securely. (Figure 12)



a - Pump Lever
b - Set Screw
c - Pump Shaft and Lever Assembly
d - Washer
e - Air Horn

Figure 12. Installing Accelerator Pump Assembly and Pump Shaft and Lever Assembly

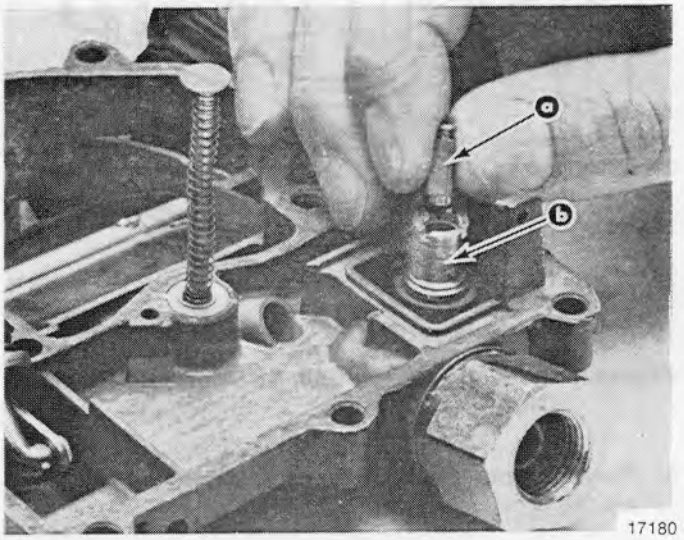


a - Needle Seat
b - Gasket
c - Screwdriver

Figure 13. Installing Needle Seat and Gasket

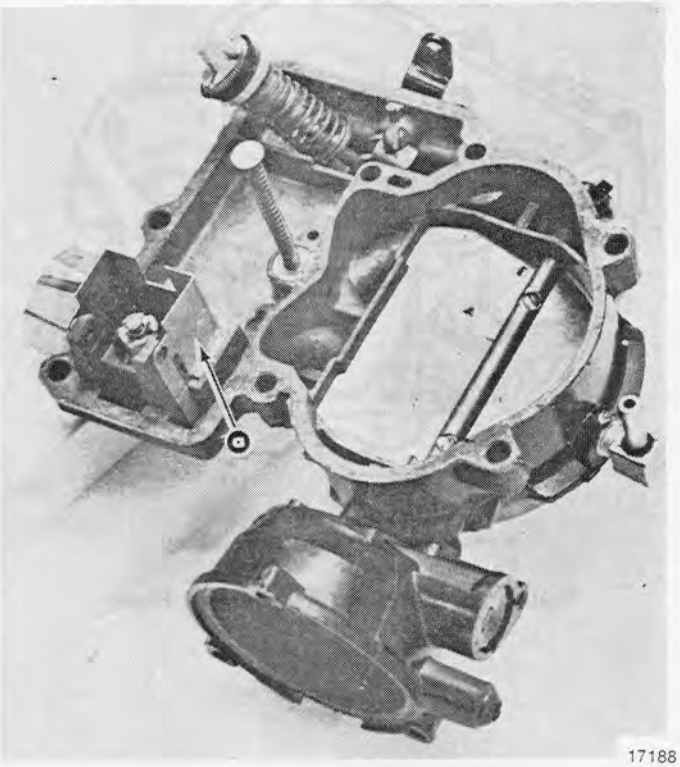
IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

4. Install needle seat and gasket, using appropriate width screwdriver. (Figure 13)
5. Place needle assembly in needle seat. (Figure 14)
6. Install baffle. (Figure 15)
7. Place new gasket on air horn. (Figure 16)
8. Install float assembly and hinge pin. (Figure 17) Pivot float assembly up-and-down on hinge pin to ensure it moves freely. Set float level and drop to specifications.



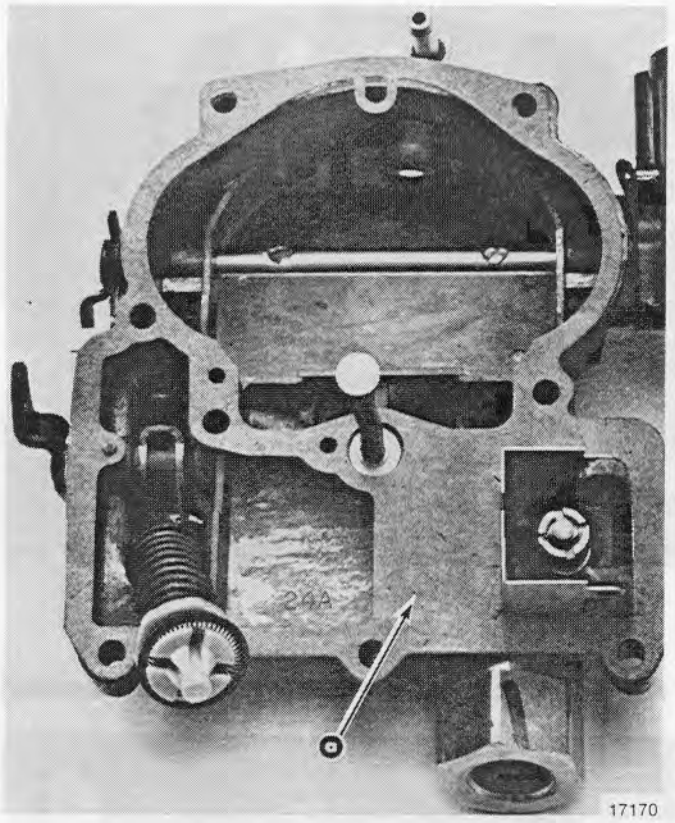
a - Needle Assembly
b - Needle Seat

Figure 14. Installing Needle Assembly



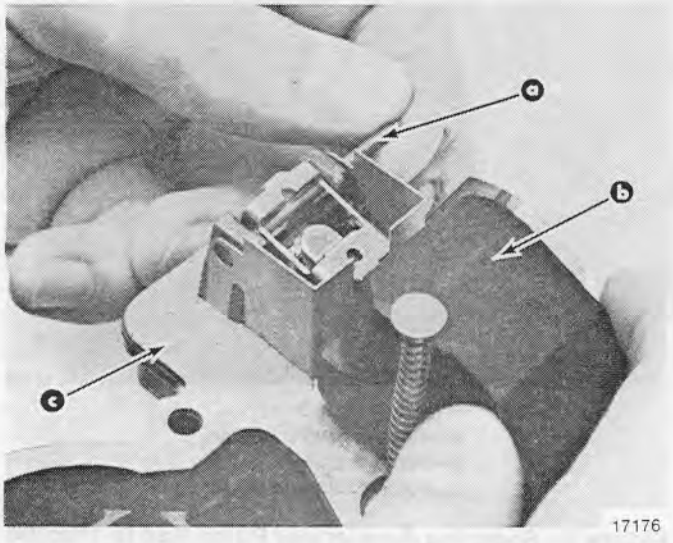
a - Baffle

Figure 15. Installing Baffle



a - Gasket

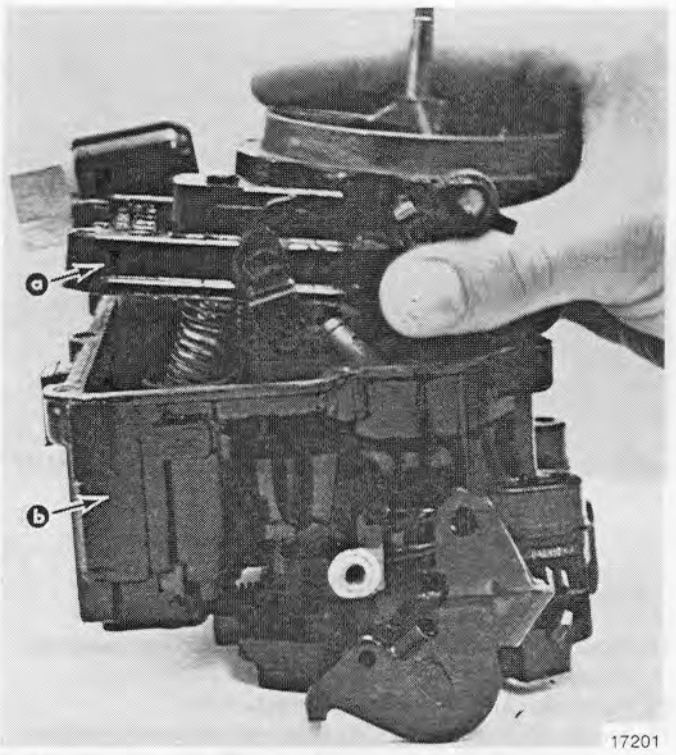
Figure 16. Installing Air Horn Gasket



a - Float Hinge Pin
b - Float Assembly
c - Gasket

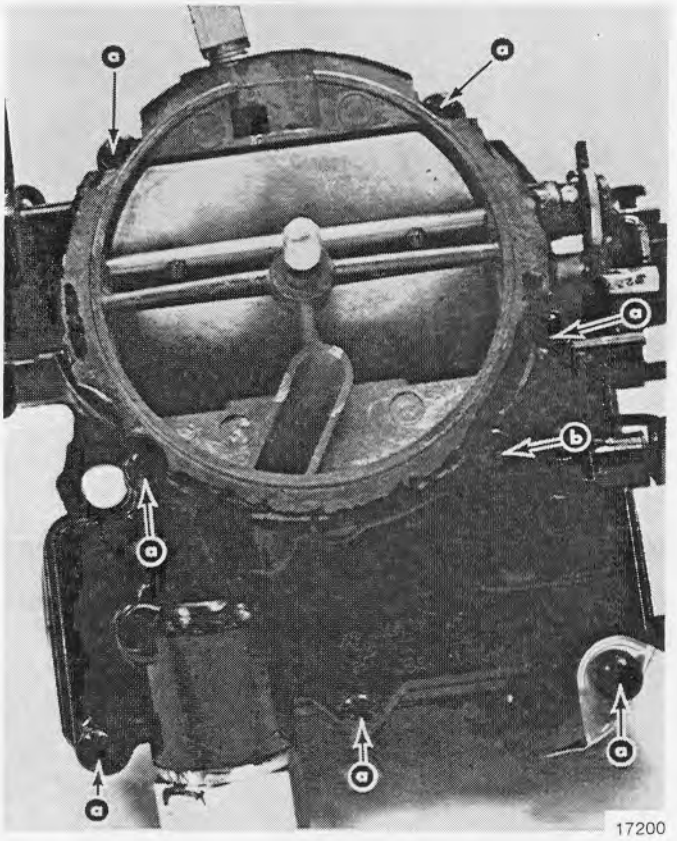
Figure 17. Installing Float Assembly and Hinge Pin

9. Place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn gently, straight down, to insure proper installation. (Figure 18)
10. Install seven short and one long air horn attaching screws. Tighten screws evenly and securely. (Figure 19)



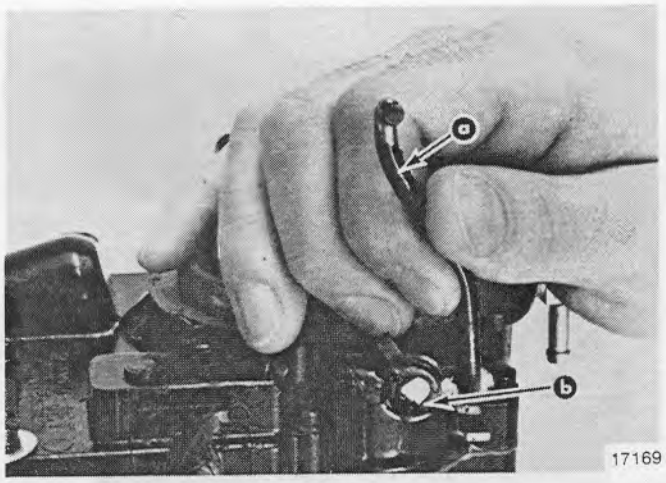
a - Air Horn
b - Float Bowl Assembly

Figure 18. Carefully Installing Air Horn



a - Seven Short Screws
b - One Long Screw

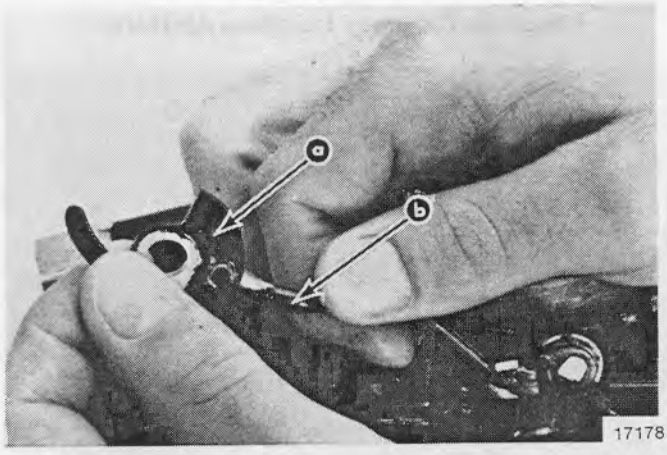
Figure 19. Installing Air Horn Attaching Screws



a - Choke Rod
b - Choke Lever and Collar Assembly

Figure 20. Installing Choke Rod

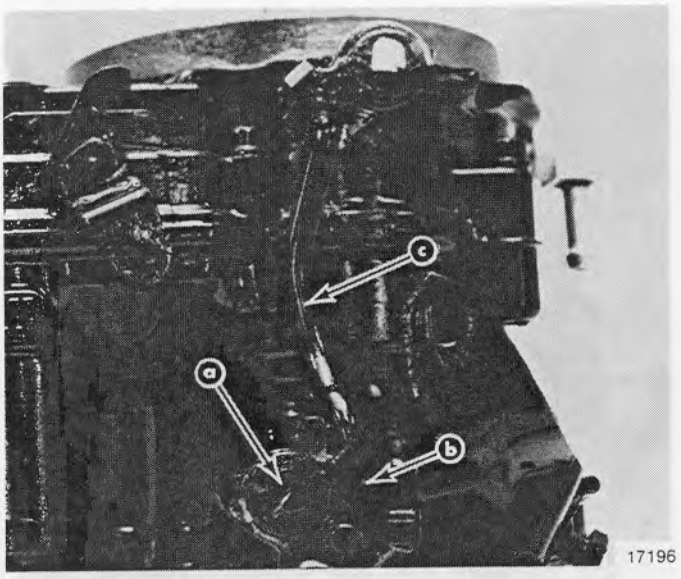
11. Place end of choke rod in choke lever and collar assembly. (Figure 20)
12. Place idle cam on choke rod. (Figure 21)
13. Secure idle cam (with choke rod installed on cam) on float bowl assembly, using screw. (Figure 22) Check that cam is free to move without binding.



a - Idle Cam
b - Choke Rod

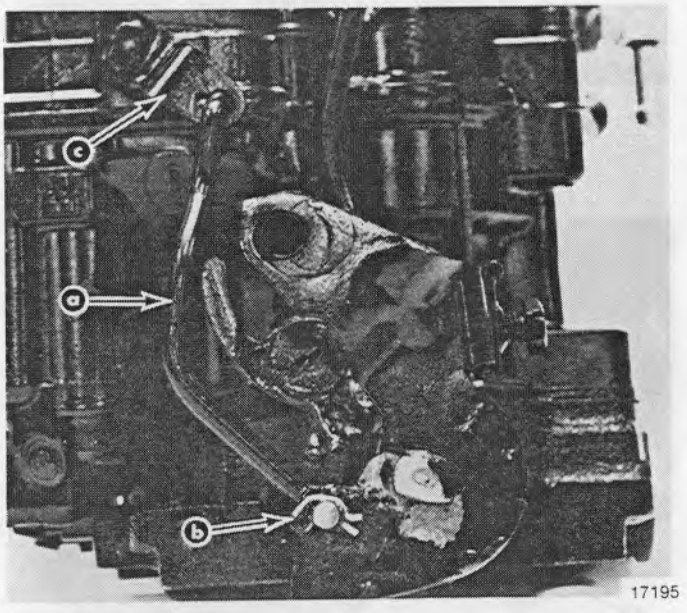
Figure 21. Installing Idle Cam

14. Place accelerator pump rod (end with ear) in hole in pump shaft and lever assembly. (Figure 23)
15. Insert remaining end of accelerator pump rod into hole in throttle lever and secure with retainer clip. (Figure 23)



a - Screw
b - Idle Cam
c - Choke Rod

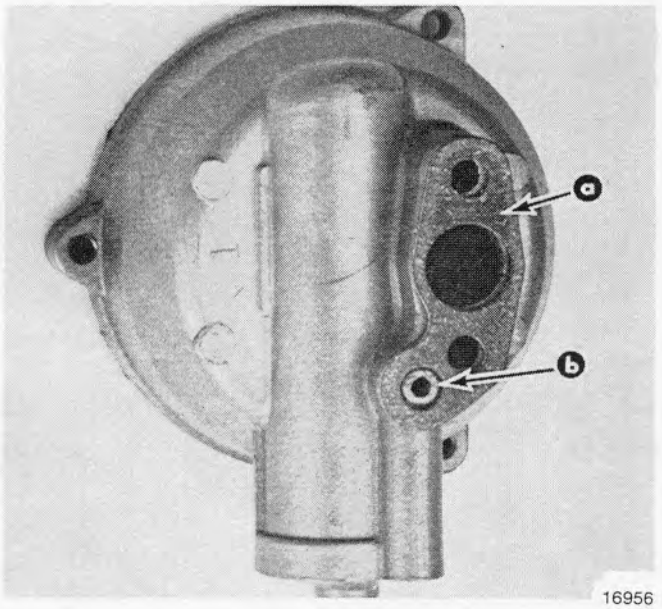
Figure 22. Securing Idle Cam to Float Bowl Assembly



a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever

Figure 23. Securing Accelerator Pump Rod to Throttle Lever

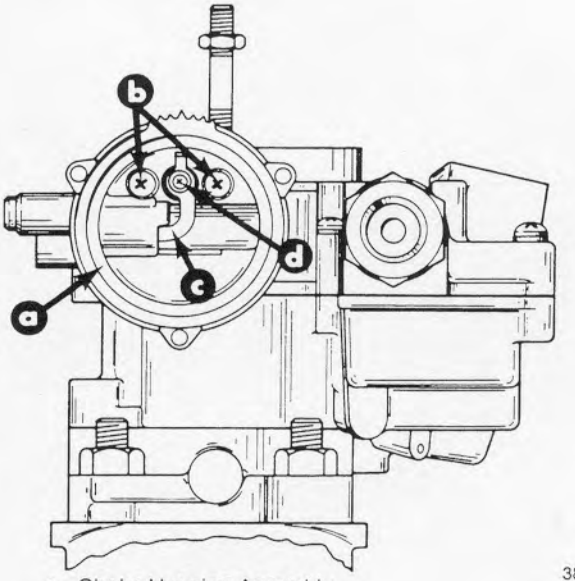
Choke Housing Assembly



a - Gasket
b - Choke Housing Assembly Gasket Locating Pin

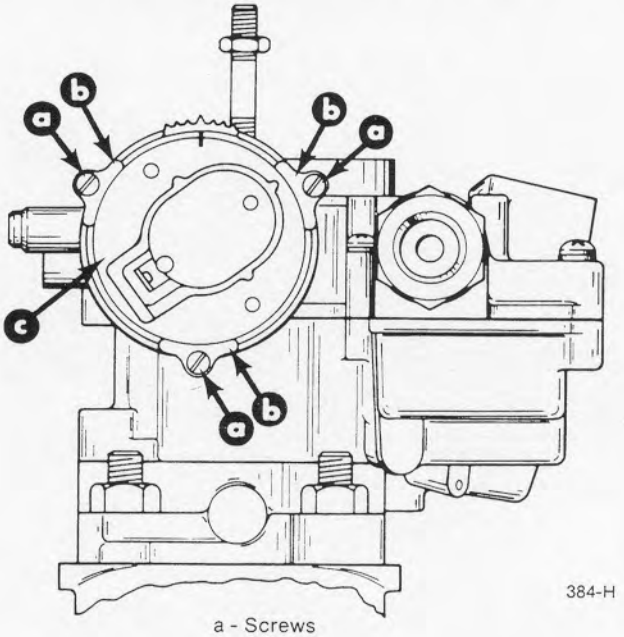
Figure 24. Installing Choke Housing Assembly Gasket

1. Place new choke housing gasket in position on air horn making sure that, when installing choke housing assembly, locating pin on housing inserts into hole in gasket. (Figure 24)
2. Secure choke housing assembly to air horn with two attaching screws. (Figure 25) Tighten screws securely.
3. Fasten choke lever to choke shaft assembly with screw, as shown in Figure 25.
4. Place choke cover on choke housing. Be sure hook on end of heating coil engages with choke lever. Rotate choke cover until alignment marks (made at disassembly) line up.
5. Secure choke cover with three screws and retainers (Figure 26), being sure ground terminal is fastened under bottom screw, if carburetor has an electric choke element.



a - Choke Housing Assembly
b - Choke Housing Assembly Attaching Screws
c - Choke Lever
d - Choke Lever Screw

Figure 25. Installing Choke Housing Assembly and Choke Lever Assembly to Air Horn

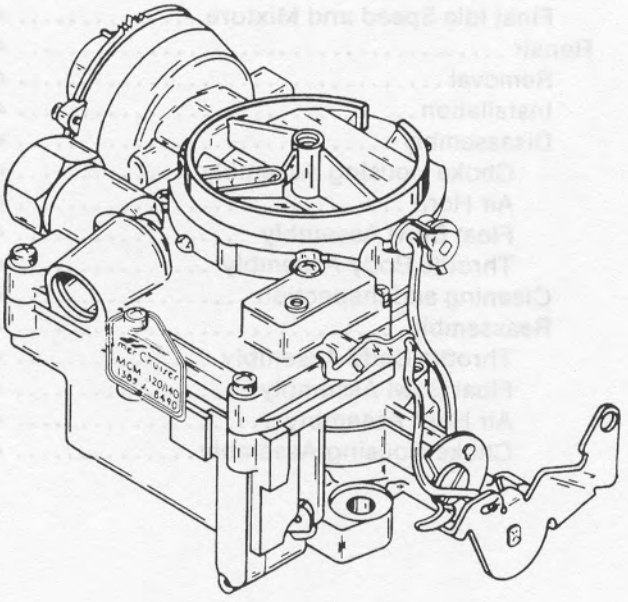


a - Screws
b - Retainer
c - Choke Cover

Figure 26. Installing Choke Cover

SECTION 4 - FUEL SYSTEM

PART C - MERCARB® 2 BARREL



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STERN DRIVES & INBOARDS

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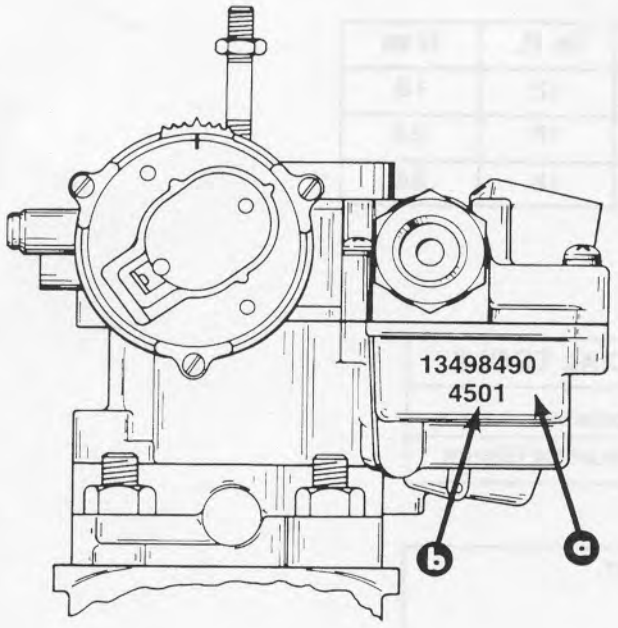
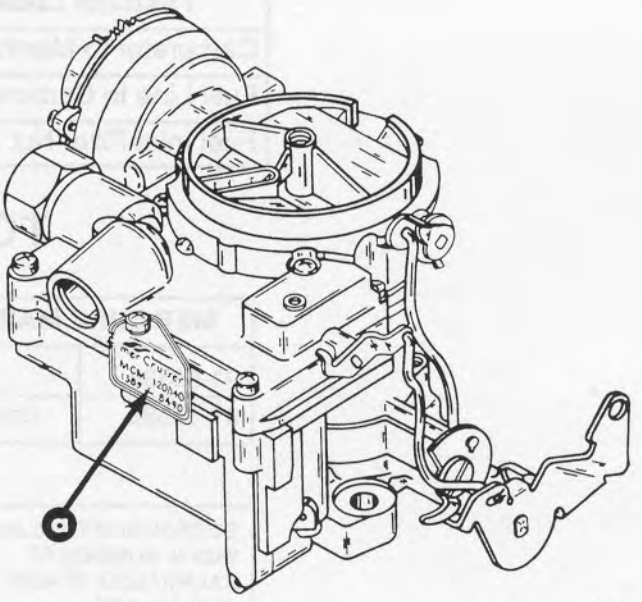
IDENTIFICATION



384-H

a - Part Number
b - Date Code

Figure 1. Carburetor Part Number Location



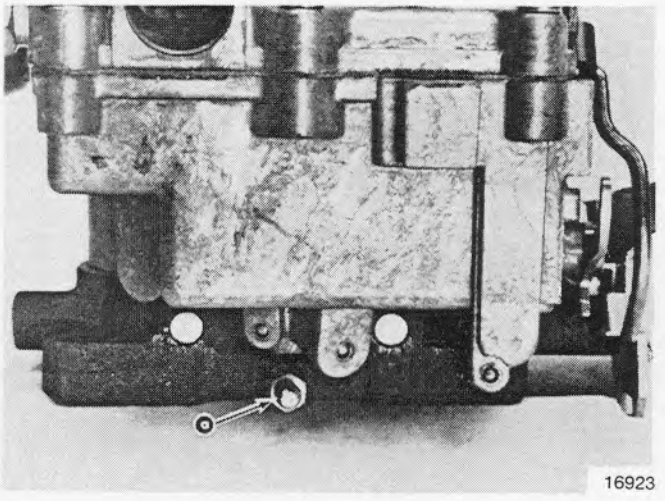
392-H

a - Part Number

Figure 2. Part Number Tag Location

Date Code Explanation: Example 4501

First Figure is Year
4 = 1984, 5 = 1985, etc.
Second Figure is Month
5 = May, 6 = June, 7 = July, etc.
X = October, Y = November, Z = December
Third and Fourth Figure is Day of Month
01 = First day, 02 = Second day, etc.



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a - Single Idle Mixture Needle

Figure 3. MerCarb Carburetor

REPLACEMENT PARTS WARNING

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	lb. ft.	N·m
Carburetor to Manifold	12	16
Fuel Line to Carburetor	18	24
Fuel Inlet Filter Nut	18	24

TOOLS

MERCURY MARINE SPECIAL TOOLS	
91-59339	Tachometer
91-36392	Universal Carburetor Gauge

BORROUGHS TOOL and EQUIPMENT 2429 N. BURDICK ST. KALAMAZOO, MI 49007 (616) 345-5163	
BT 8128B	Float Gram Scale

SPECIFICATIONS

CARBURETOR MODEL SPECIFICATIONS

Model	Type	Mercury Number	Primary Jet Size	Power Valve Size
MCM 120R/140R	MerCarb® 32mm	1389-8490	1.45mm	.84mm
MCM 470R	MerCarb® 35mm	1389-8489	1.65mm	.9mm
MCM 898R	MerCarb® 35mm	1389-8488	1.7mm	1mm

UNIT OF MEASUREMENT
in. (mm)

CARBURETOR ADJUSTMENT SPECIFICATIONS (Note 1)

Engine Model	MCM 120R/140R	MCM 470R	MCM 898R
Carburetor Number	1389-8490	1389-8489	1389-8488
Float Level (Note 2)	(Note 3)	5/8 (15.8)	
Float Drop (Note 2)	1-3/4 (44.5)		
Pump Rod	1-5/32 (29)		
Choke Setting	Index Marks Aligned		
Choke Unloader	.080 5/64 (2)		
Idle Mixture Screw Preliminary Setting	1-1/4 Turns		
Float Weight	9 Grams Max.		

NOTES: 1. All measurements are ± 1/64" (.4mm). Information contained in this chart supercedes all service bulletins and service information printed in 1984 and earlier.
2. Measurement is taken from gasket. Fuel inlet needle is spring loaded. Before checking, raise float and allow to fall by itself. **DO NOT FORCE** downward by hand.
3. Spring loaded needle: 5/8" (15.8mm)
Solid needle: 1/4" (6.3mm)

DESCRIPTION

This MerCarb carburetor is a two bore carburetor and has a separate fuel feed for each venturi. This model also is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are a fixed orifice type that work together with fixed air bleeds to properly meter the correct fuel/air mixture to the engine.

PRECAUTIONS

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION

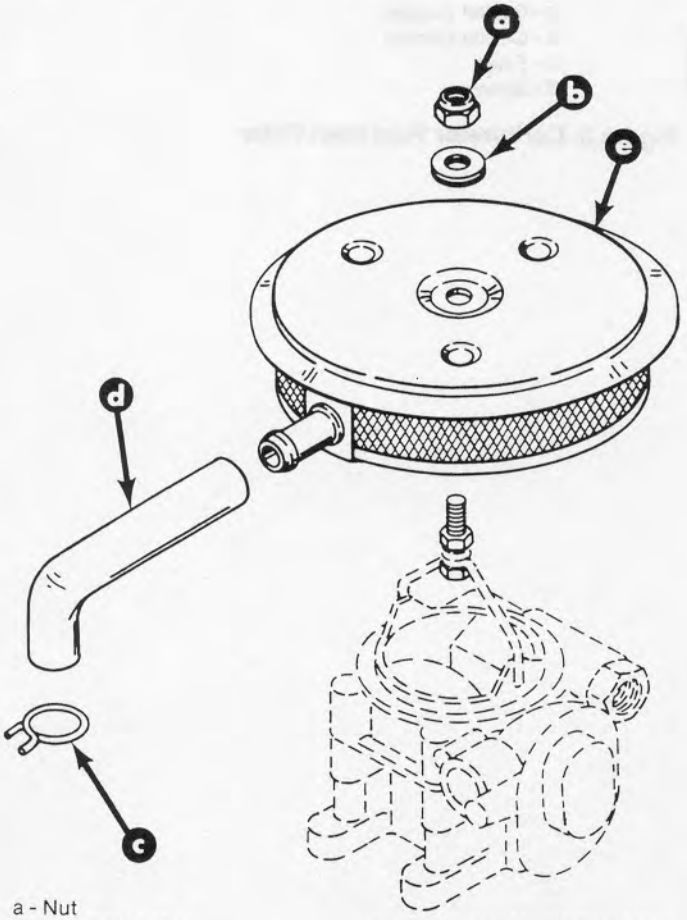
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

FLAME ARRESTOR

NOTICE

Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove in the following order: (Figure 1)
   a. Nut.
   b. Sealing washer.
   c. Hose clamp and crankcase ventilation hose - From flame arrestor and rocker arm cover.
   d. Flame arrestor - Lift from carburetor.
2. Clean and inspect: (Figure 1)
   a. Clean flame arrestor by blowing it out with compressed air.
   b. Clean crankcase ventilation hose.
   c. Inspect crankcase ventilation hose for cracks or deterioration, and replace if necessary.
3. Install in the following order: (Figure 1)
   a. Flame Arrestor - Place on carburetor.
   b. Crankcase ventilation hose and hose clamp - To flame arrestor and rocker arm cover.
   c. Sealing washer.
   d. Nut - Tighten securely, but do not overtighten.



a - Nut
b - Sealing Washer
c - Hose Clamp
d - Crankcase Ventilation Hose
e - Flame Arrestor

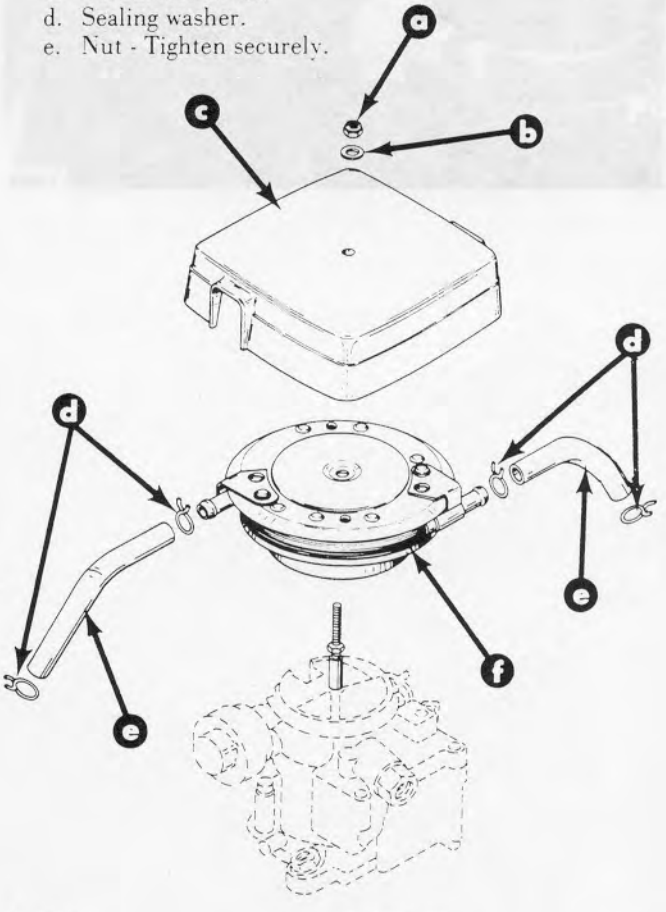
Figure 1. Flame Arrestor

FLAME ARRESTOR WITH CARBURETOR COVER

NOTICE

Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove in the following order: (Figure 2)
   a. Nut.
   b. Sealing washer.
   c. Carburetor cover.
   d. Hose clamps and crankcase ventilation hoses - From flame arrestor and rocker arm covers.
   e. Flame arrestor - Lift from carburetor.
2. Clean and inspect: (Figure 2)
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.
3. Install in the following order: (Figure 2)
   a. Flame arrestor - Place on carburetor.
   b. Crankcase ventilation hoses and hose clamps - To flame arrestor and rocker arm covers.
   c. Carburetor cover.
   d. Sealing washer.
   e. Nut - Tighten securely.



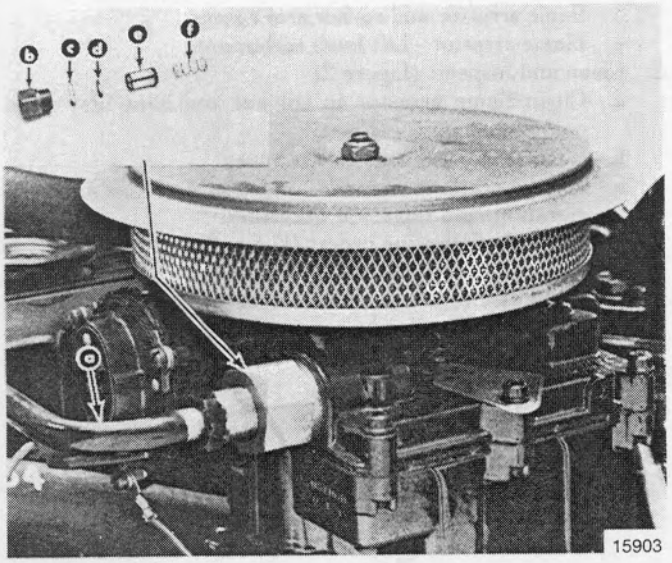
a - Nut
b - Washer
c - Carburetor Cover
d - Clamps
e - Crankcase Ventilation Hoses
f - Flame Arrestor

Figure 2. Flame Arrestor with Carburetor Cover

FUEL INLET FILTER

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove in the following order: (Figure 3)
   a. Fuel line from fuel inlet filter nut.
   b. Fuel inlet filter nut.
   c. Large gasket.
   d. Filter.
   e. Spring.
   f. Small gasket - From inside filter nut.



2. Clean filter nut and spring in solvent and dry with compressed air.
3. Install in the following order: (Figure 3)
   a. Spring - Place in carburetor body.
   b. Filter - Open end to inlet filter nut.
   c. Small gasket - Place inside filter nut.
   d. Large gasket - Place over filter nut.
   e. Fuel inlet filter nut - Torque to specifications.
   f. Fuel line - Torque to specifications.

CHOKE INSPECTION

The choke does not require any periodic maintenance; however, if a choke malfunction is suspected, the following should be done:

1. With engine off, remove flame arrestor.
2. Open and close choke several times, and check for binding, loose or disconnected linkages, or other signs of damage.
3. If choke or linkage binds, sticks, or works sluggishly, clean with carburetor choke cleaner. Follow directions on can.

a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Large)
d - Gasket (Small)
e - Filter
f - Spring

Figure 3. Carburetor Fuel Inlet Filter

ADJUSTMENTS

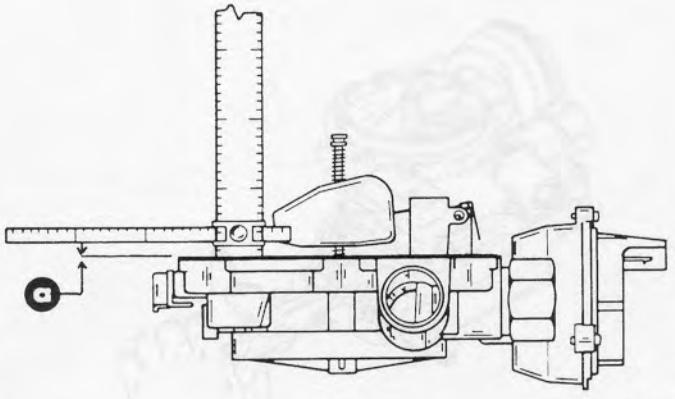
NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

FLOAT LEVEL

1. Turn air horn upside down. Pivot float assembly up-and-down on hinge pin to ensure it moves freely.

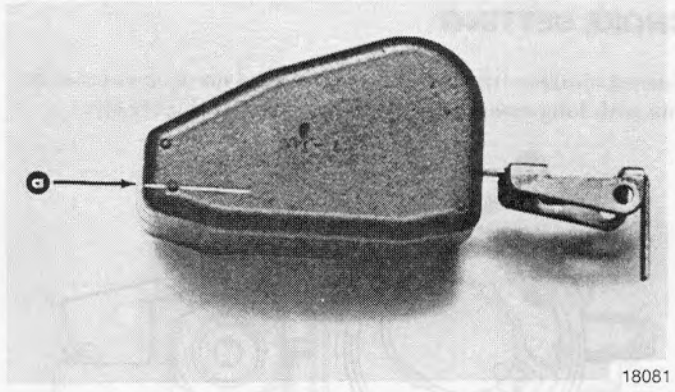
   IMPORTANT: Before checking float level, raise float and allow it to fall; however, DO NOT force downward by hand.

2. Using Universal Carburetor Gauge, measure from gasket to toe of float. (Figure 1 and 1A)



a - See Specifications

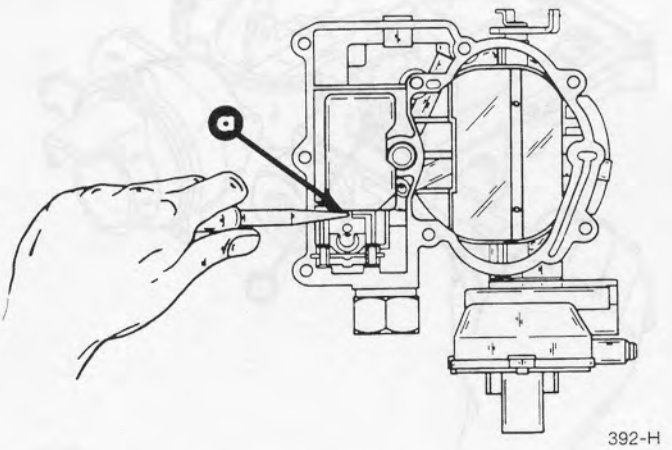
Figure 1. Measuring Float Level



a - Measure from This Point to Gasket

Figure 1A. Toe of Float

3. Bend float arm up or down at point shown in Figure 2, to obtain specified dimension.
4. Visually check float alignment after adjustment.

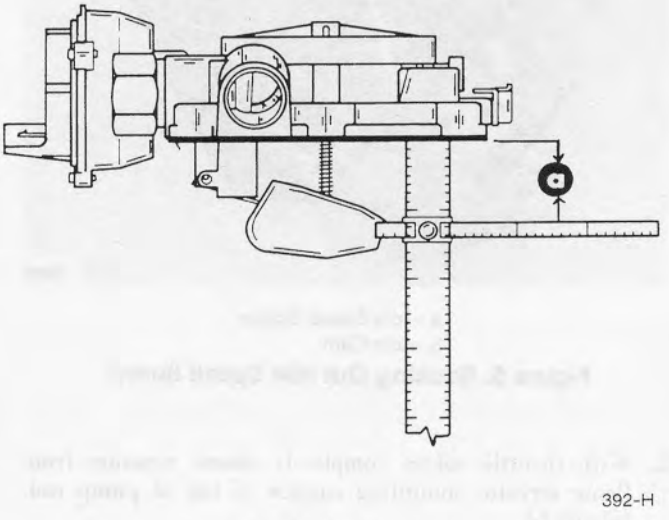


a - Bend Float Arm at this Point

Figure 2. Adjusting Float Level

FLOAT DROP

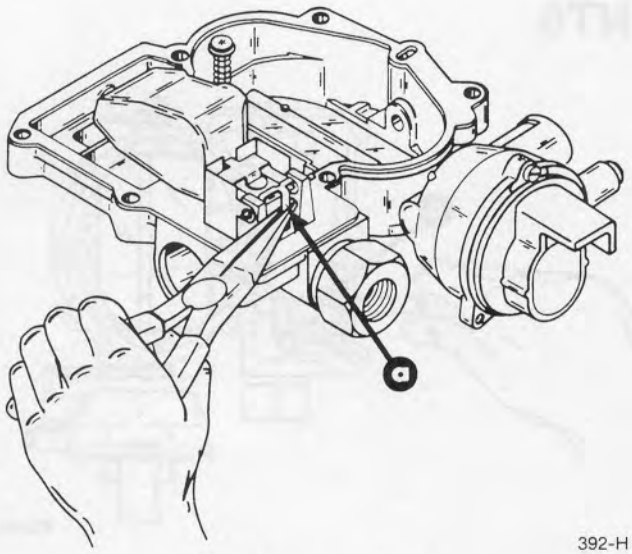
1. Hold air horn right-side-up to allow float to hang free.
2. Using Universal Carburetor Gauge, measure from gasket to toe of float. (Figure 3)



a - See Specifications

Figure 3. Measuring Float Drop

3. Bend float assembly tang, as shown in Figure 4, to obtain specified dimension.
4. Recheck BOTH float level and float drop.

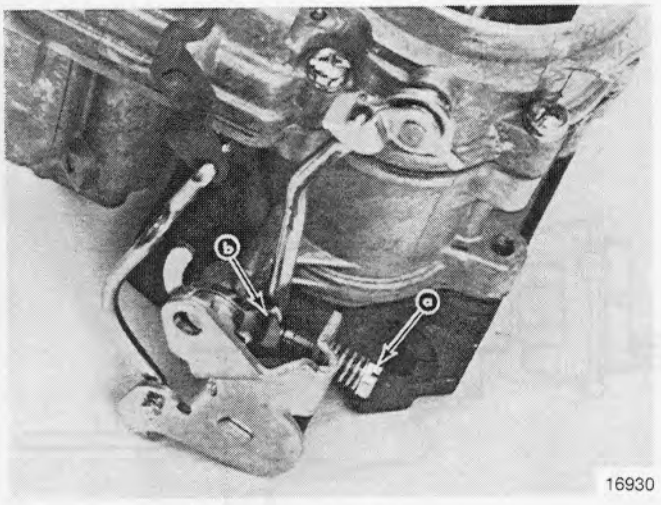


a - Float Assembly Tang

Figure 4. Adjusting Float Drop

PUMP ROD

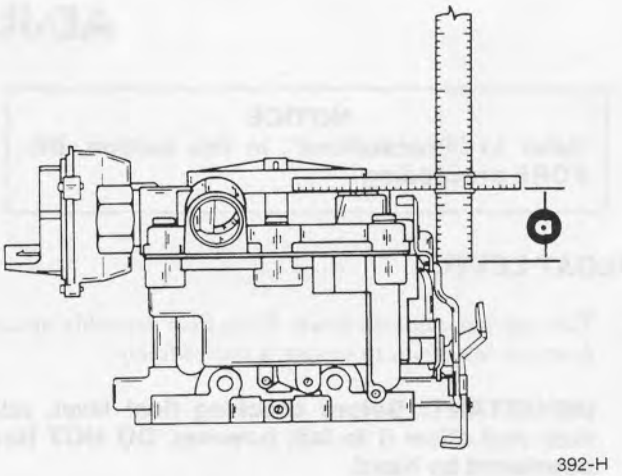
1. Back out idle speed screw until it no longer contacts idle cam. (Figure 5)



a - Idle Speed Screw
b - Idle Cam

Figure 5. Backing Out Idle Speed Screw

2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod. (Figure 6)
3. Carefully bend pump rod (where shown) to obtain specified dimension. (Figure 7)



a - See Specifications

Figure 6. Measuring Pump Rod

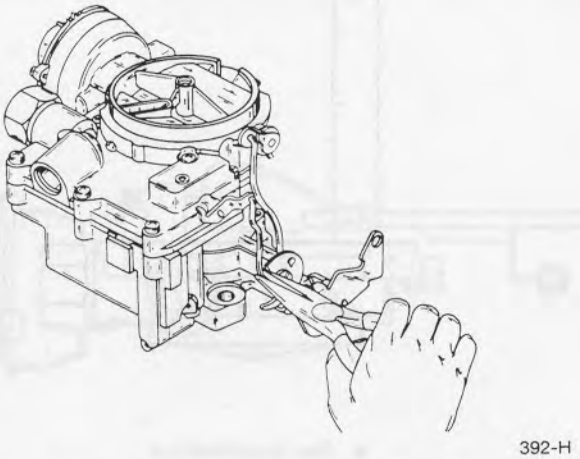
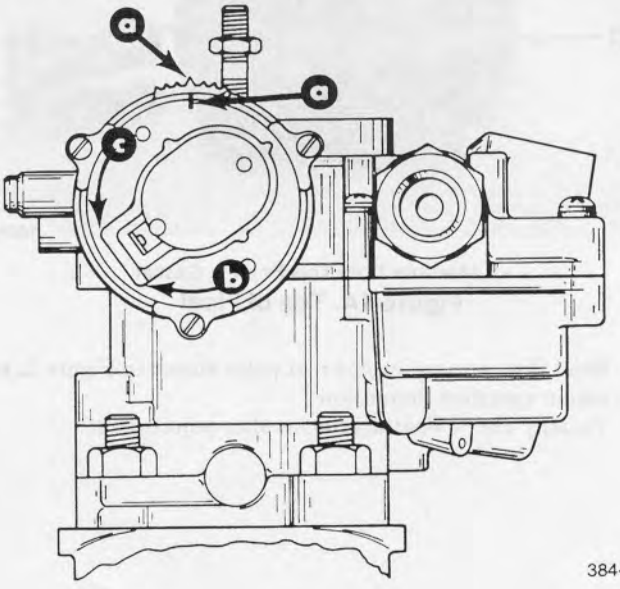


Figure 7. Adjusting Pump Rod

CHOKE SETTING

Normal choke setting is such that scribed mark on cover is in line with long case mark on choke housing. (Figure 8)



a - Marks on Choke Cover and Choke Housing
b - Leaner
c - Richer

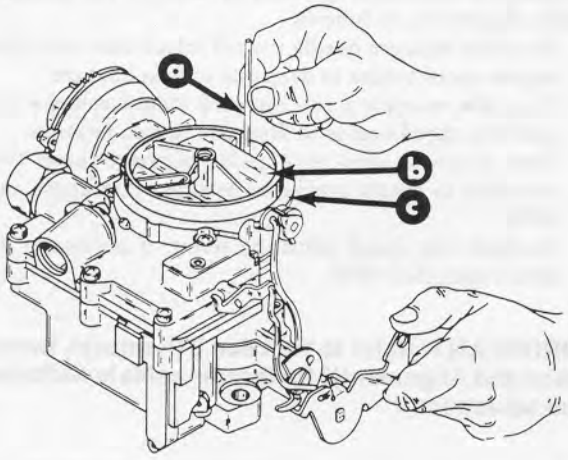
Figure 8. Choke Setting

If choke adjustment is necessary:

1. Loosen 3 choke cover retaining screws and adjust as shown.
2. Tighten 3 choke cover retaining screws securely.

CHOKE UNLOADER

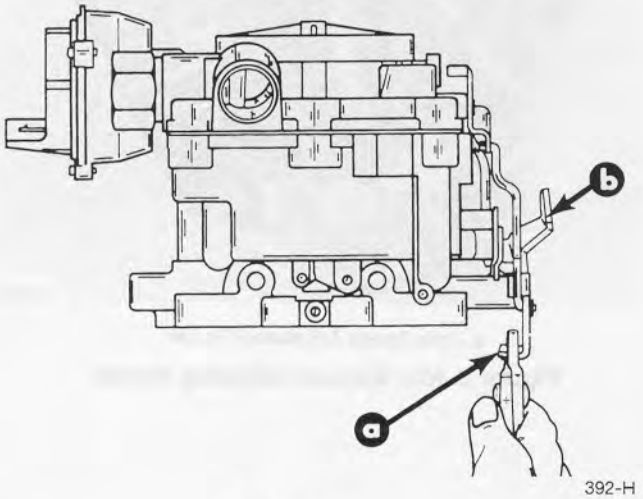
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an .080 in. (2.0mm) drill rod, or appropriate gauge, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through. (Figure 9) If adjustment is required, proceed to Step 4.
4. Bend tang on throttle lever, if necessary, to obtain specified dimension. (Figure 10)



392-H

a - .080 In. (2.0mm) Drill Rod
b - Choke Plate
c - Air Horn

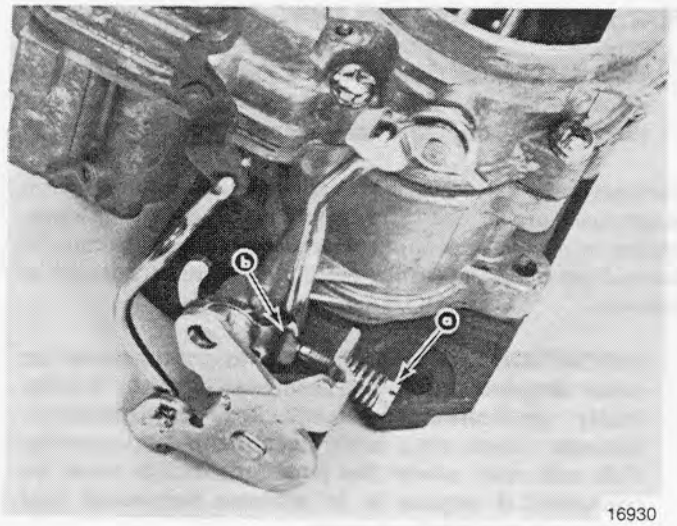
Figure 9. Checking Choke Unloader



392-H

a - Tang
b - Throttle Lever

Figure 10. Adjusting Choke Unloader



16930

a - Idle Speed Screw
b - Idle Cam

Figure 11. Preliminary Adjustment of Idle Speed Screw

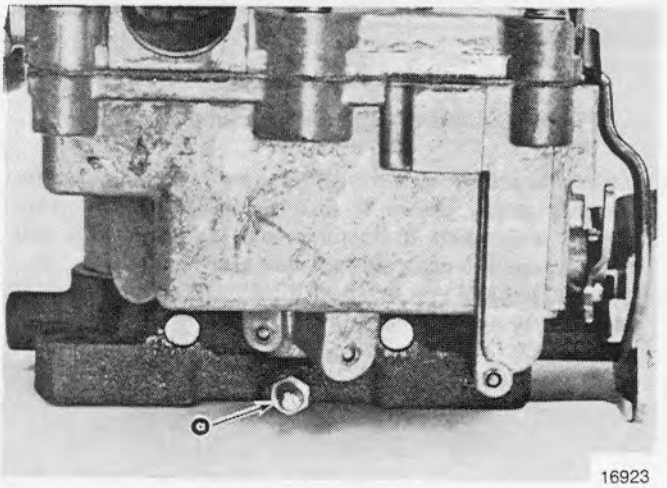
PRELIMINARY IDLE SPEED and MIXTURE

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Turn idle speed screw in until it just contacts idle cam: then, turn screw in an additional two turns. (Figure 11)

IMPORTANT: DO NOT turn idle mixture needle tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needle in until they lightly seat; then, back needle out 1¼ turns. (Figure 12)



16923

a - Idle Mixture Needle

Figure 12. Preliminary Idle Mixture Adjustment

FINAL IDLE SPEED and MIXTURE

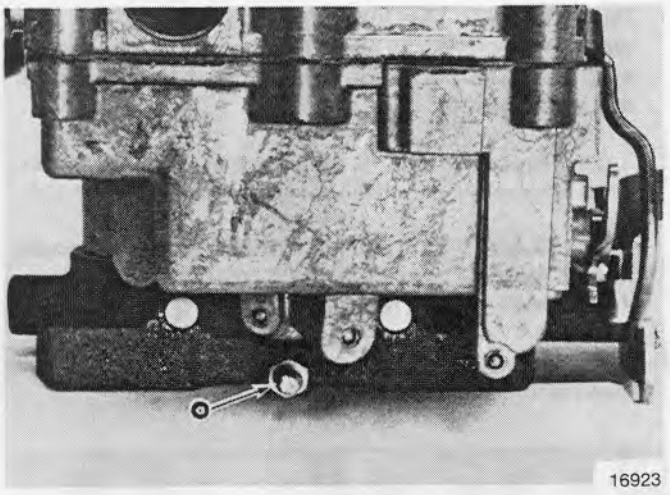
IMPORTANT: Boat must be in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under "Specifications", with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect an accurate shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needle (Figure 1) tightly into seat, as damage to needle and/or seat may result.



a - Idle Mixture Needle

Figure 2. Carburetor Idle Mixture Needle

2. If a new or rebuilt carburetor has been installed, turn idle mixture needle (Figure 1) in (clockwise) until it lightly contacts seat; then, back out needle 1¼ turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

DO NOT leave the helm unoccupied while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable brass barrel from anchor stud. Be sure not to lose spacer on anchor stud.
6. Adjust idle speed adjustment screw (Figure 2) to obtain specified RPM.
7. With engine running at specified RPM, adjust idle mixture needle (Figure 1), as follows:
   a. Turn idle mixture needle inward (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw outward (counterclockwise) until the speed begins to drop due to rich mixture.
   c. Turn screw inward to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Readjust idle speed adjusting screw, if necessary, to obtain specified RPM.

IMPORTANT: Refer to "Section 2 (Removal, Installation and Alignment)" for throttle cable installation and adjustment.

a - Idle Speed Adjustment Screw

Figure 2. Idle Speeed Adjusting Screw

REPAIR

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

REMOVAL

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

1. Remove ventilation hose from flame arrestor; then, remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove swivel link assembly from carburetor.
5. Remove fuel line from fuel inlet nut.
6. Remove fuel pump sight tube from carburetor.
7. Disconnect electric choke.
8. Remove carburetor attaching nuts and washers and remove carburetor.
9. Remove and discard gaskets.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

INSTALLATION

1. Thoroughly clean gasket surfaces.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to specifications.
3. Connect fuel line to fuel inlet nut and torque to specifications.
4. Conncet fuel pump sight tube to fitting on carburetor.
5. Connect electric choke wires to choke cover.
6. Check to ensure that 8-12 threads of link rod are exposed from swivel; then, attach swivel link assembly to throttle lever, using nut and washer.
7. Move intermediate throttle lever back-and-forth and check for binding in throttle linkage. If binding occurs, remove swivel link assembly from throttle lever and adjust link (by turning link rod), as required, to eliminate binding.
8. Install throttle cable, as explained, in "Section 2".
9. Install flame arrestor and crankcase ventilation hose.
10. Reconnect battery cables to battery.
11. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
12. Adjust idle speed and idle mixture, as outlined under "Adjustments" preceding.

DISASSEMBLY

The following is a step-by-step procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessary steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

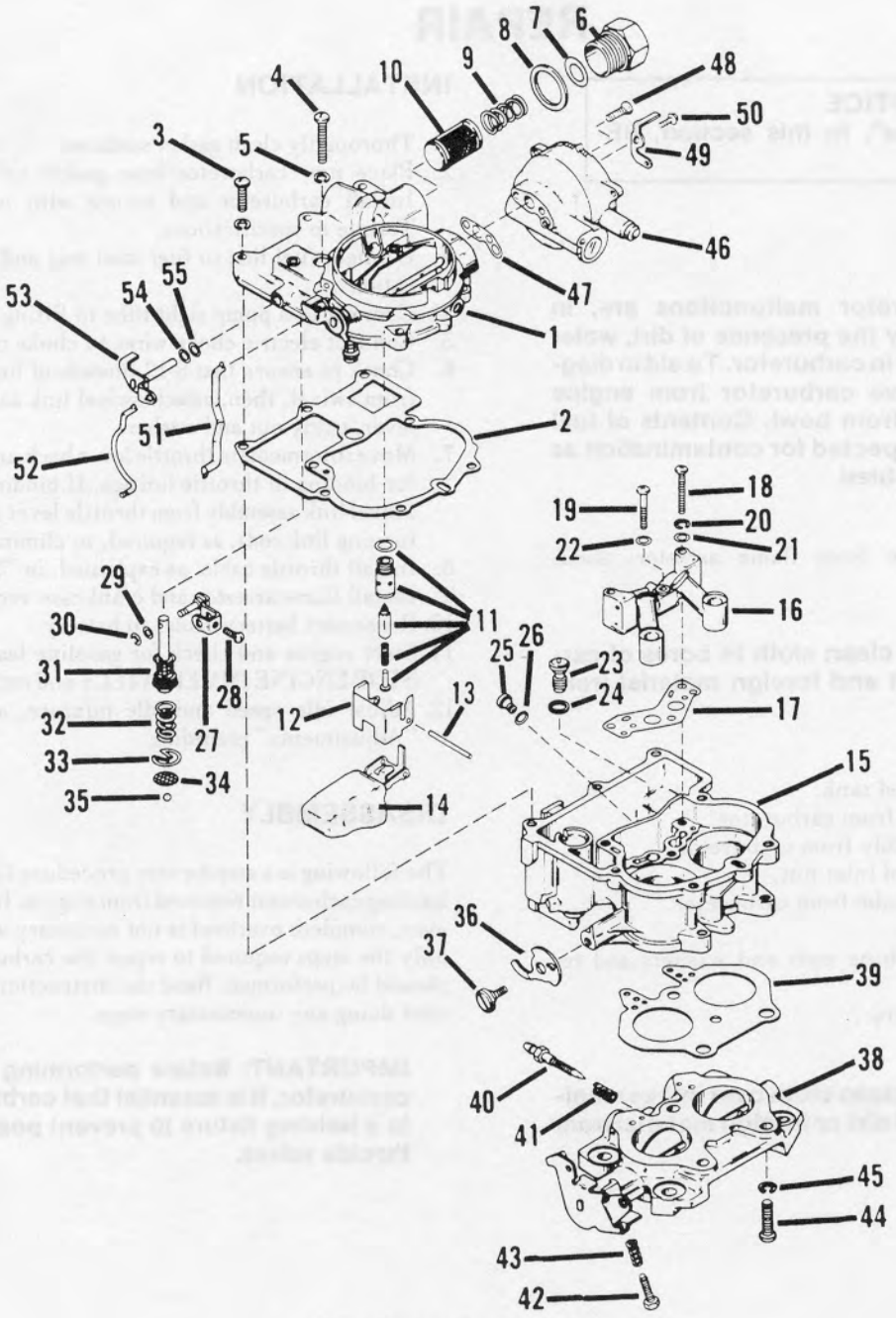
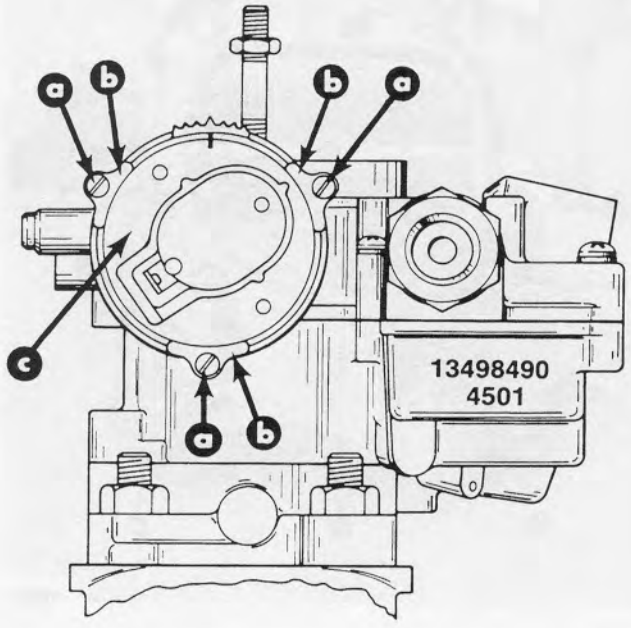


Figure 1. MerCarb Two-Barrel

1 - Air Horn
2 - Gasket
3 - Screw
4 - Screw
5 - Lockwasher
6 - Nut - Fuel Inlet
7 - Gasket
8 - Gasket
9 - Spring
10 - Filter
11 - Inlet Needle and Seat
12 - Baffle Plate
13 - Pin
14 - Float
15 - Float Bowl
16 - Venturi Cluster
17 - Gasket
18 - Screw
19 - Screw
20 - Lockwasher
21 - Gasket
22 - Gasket
23 - Power Valve Assembly
24 - Gasket
25 - Jet
26 - Gasket
27 - Pump Shaft and Lever Assembly
28 - Screw
29 - Washer
30 - Clip - Retainer
31 - Accelerator Pump Assembly
32 - Spring
33 - Clip - Retainer
34 - Strainer
35 - Check Ball
36 - Cam - Idle
37 - Screw
38 - Throttle Body
39 - Gasket
40 - Idle Mixture Adjusting Needle
41 - Spring
42 - Screw - Idle Speed Adjusting
43 - Spring
44 - Screw
45 - Lockwasher
46 - Choke/Housing
47 - Gasket (Some Models)
48 - Screw
49 - Lever Assembly
50 - Screw
51 - Rod - Choke
52 - Rod - Accelerator Pump
53 - Accelerator Pump Shaft and Lever Assembly
54 - Washer - (Outer)
55 - Washer - (Inner)

Choke Housing Assembly

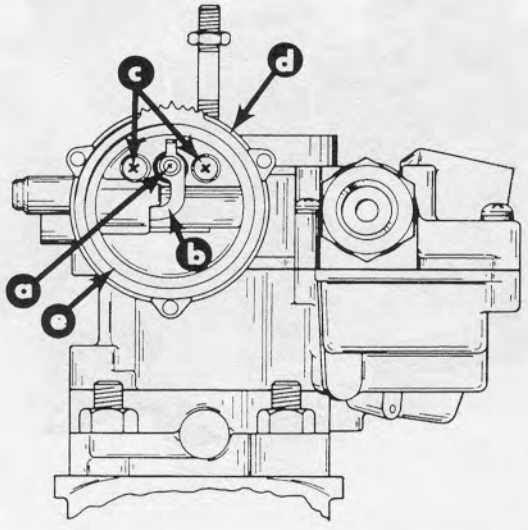
1. Remove choke cover as shown in Figure 2.



a - Screws
b - Retainers
c - Choke Cover
Remove

Figure 2. Removing Choke Cover

2. Remove choke lever as shown in Figure 3.
3. Remove choke housing assembly as shown in Figure 3.

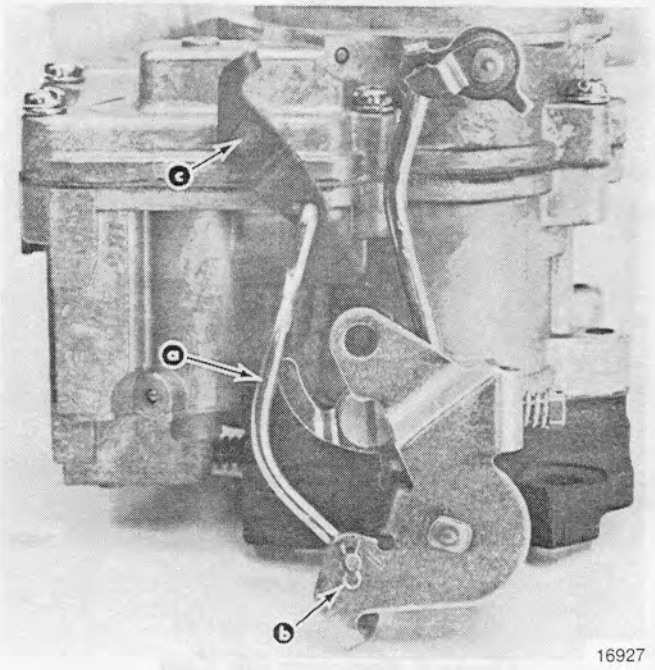


a - Screw - Choke Lever
b - Choke Lever
c - Screws - Choke Housing Assembly
d - Gasket (If Equipped)
e - Choke Housing Assembly
Remove

Figure 3. Removing Choke Lever and Choke Housing Assembly

Air Horn

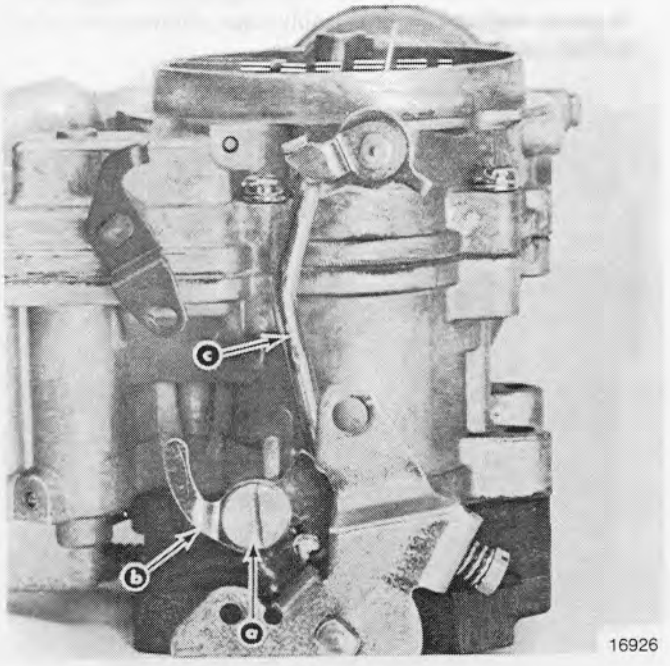
1. Remove fuel inlet filter nut, washers, spring, and filter, as outlined.
2. Remove accelerator pump rod retaining clip, (Figure 4) Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever Assembly

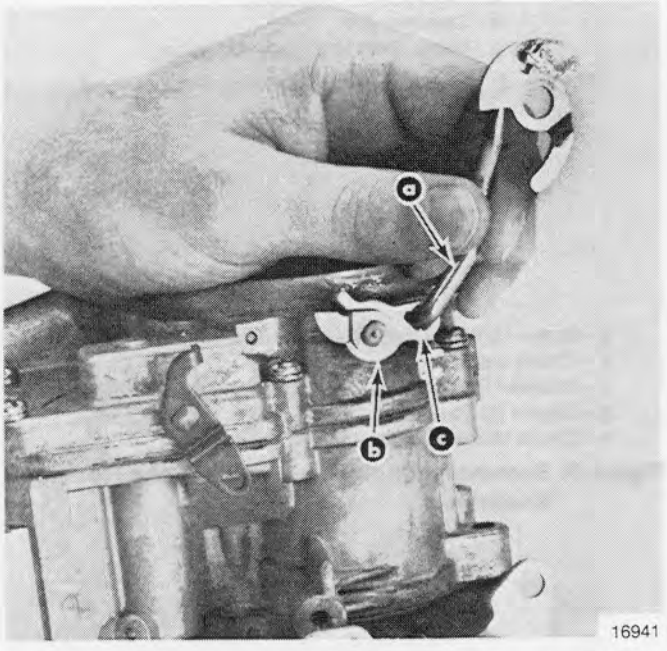
Figure 4. Removing Accelerator Pump Rod

3. Remove idle cam screw. (Figure 5) Also, remove choke rod by pivoting rod (as required) until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out. (Figure 6)



a - Idle Cam Screw
b - Idle Cam
c - Choke Rod

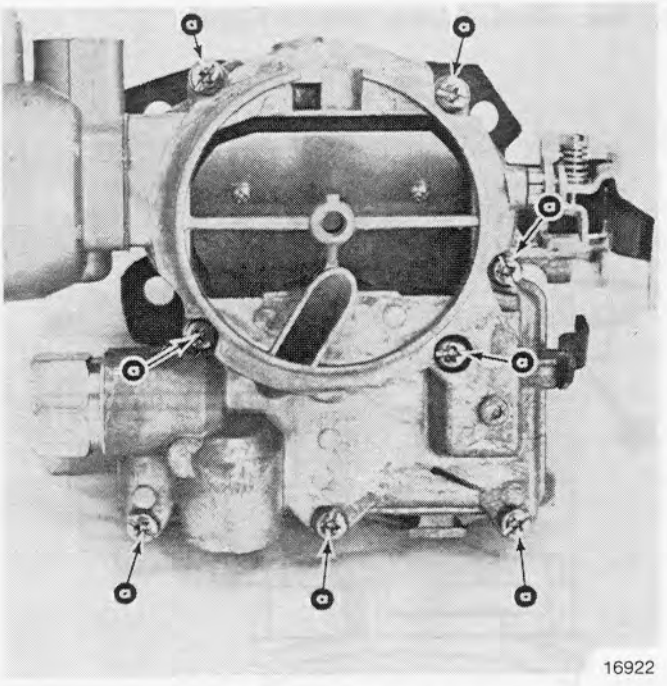
Figure 5. Removing Idle Cam



a - Choke Rod b - Choke Lever c - Slot

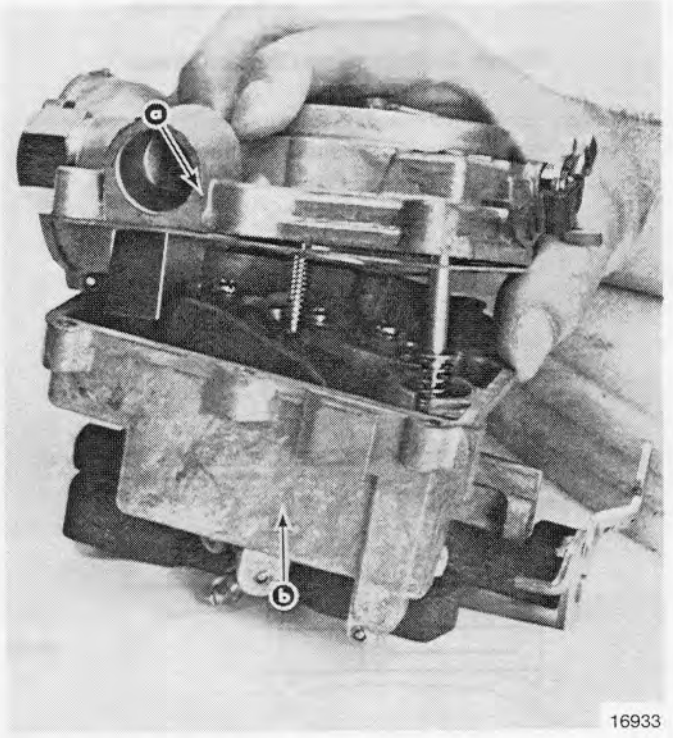
Figure 6. Removing Choke Rod

4. Remove air horn as shown in Figures 7 and 8.



a - Air Horn Attaching Screws

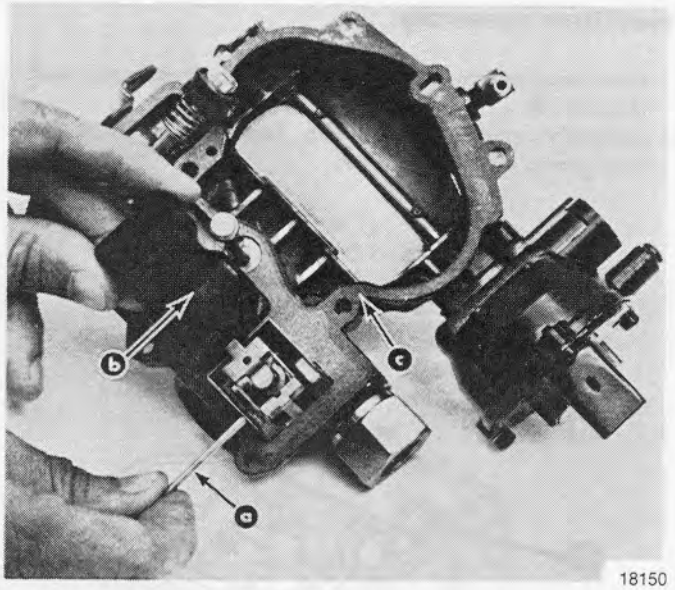
Figure 7. Air Horn Attaching Screw Location



a - Air Horn - Carefully Lift Off
b - Float Bowl Assembly

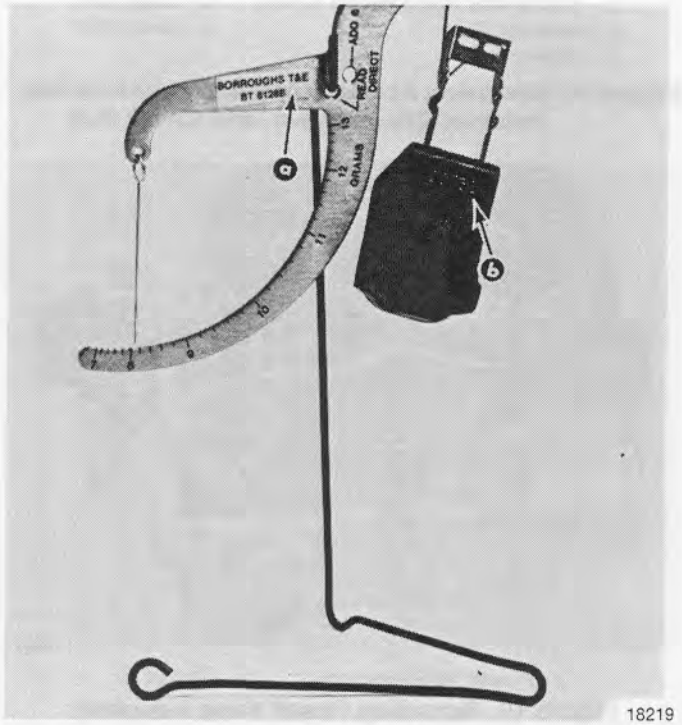
Figure 8. Carefully Removing Air Horn

5. Invert air horn and carefully lay on bench.
6. Remove float hinge pin and lift float assembly from air horn. (Figure 9). Check float weight as shown in (Figure 9A).
7. Remove air horn gasket. (Figure 9)



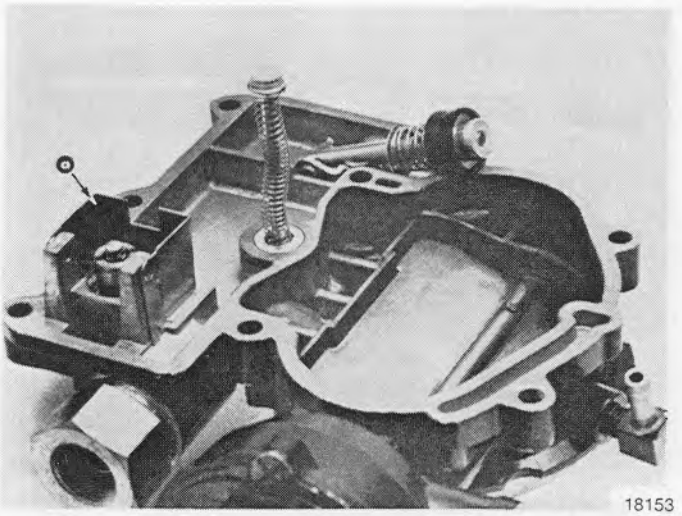
a - Float Hinge Pin
b - Float Assembly
c - Air Horn Gasket

Figure 9. Removing Float Assembly and Air Horn Gasket



a - Grams Scale
b - Float

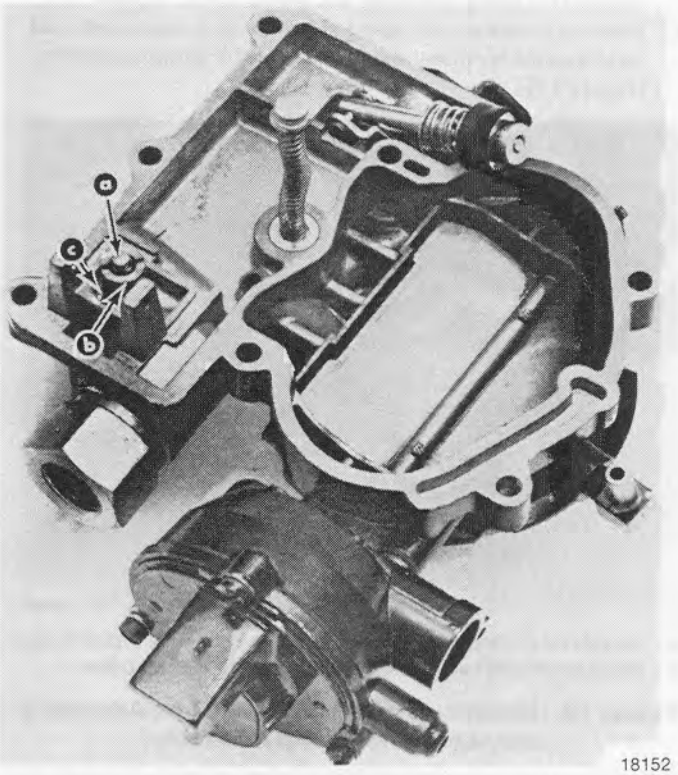
Figure 9A. Checking Float Weight



a - Baffle

Figure 10. Removing Baffle

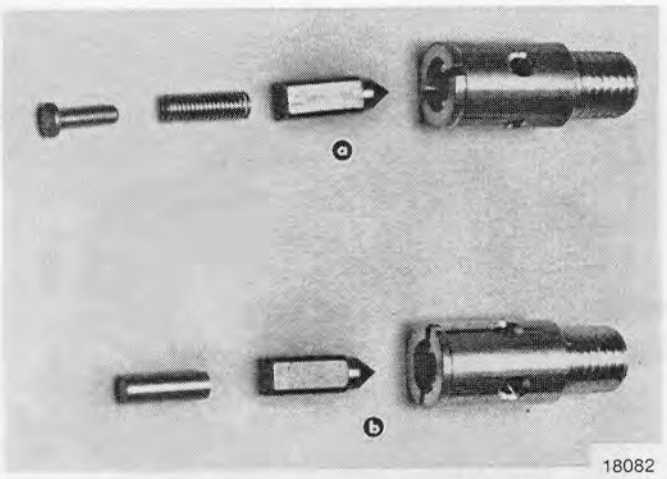
8. Remove baffle. (Figure 10)
9. Remove needle assembly. (Figure 11)
10. Remove needle seat and gasket. (Figure 11)



a - Needle Assembly b - Needle Seat c - Gasket

Figure 11. Removing Needle Assembly, Needle Seat and Gasket

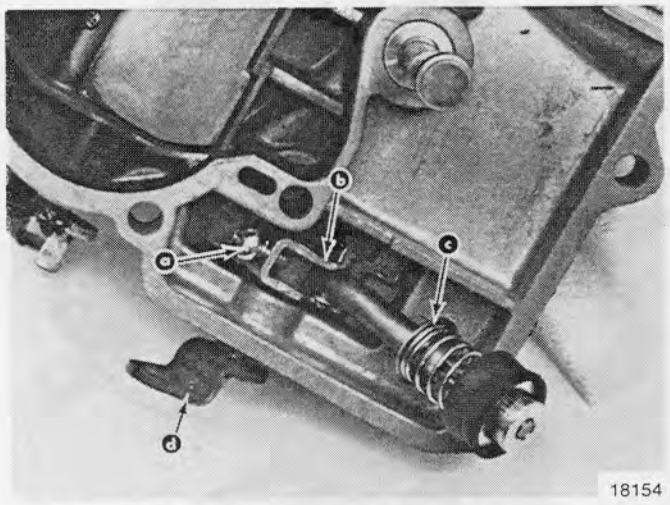
IMPORTANT: MCM 120R/140R Only: Carburetors with a date code of 4801 and above use a "solid type" needle and seat in production. Carburetors before that date code may have solid needle installed as service kit.



a - "Spring Loaded Type" Needle - MCM 120R/140R (Early Models) and MCM 470R/898R
b - "Solid Type" Needle - MCM 120R/140R (Later Models) Only

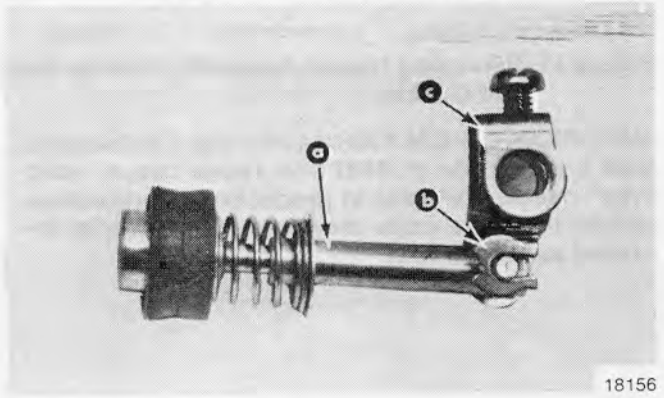
Figure 11A. Types of Needle and Seat Assemblies

11. Loosen accelerator pump screw. Slide pump shaft and lever assembly (and washer) out of air horn; then, remove accelerator pump assembly and pump lever. (Figure 12)
12. Remove retainer clip and washer from pump shaft and lever assembly; then, remove accelerator pump assembly. (Figure 13)



a - Accelerator Pump Screw
b - Pump Shaft and Lever Assembly
c - Accelerator Pump
d - Pump Lever

Figure 12. Removing Pump Shaft and Lever Assembly and Accelerator Pump Assembly



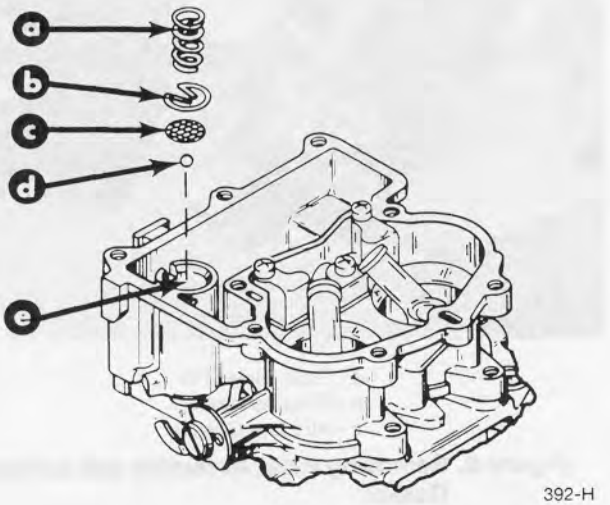
a - Accelerator Pump Assembly
b - Retainer Clip
c - Pump Shaft and Lever Assembly

Figure 13. Removing Accelerator Pump Assembly

IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

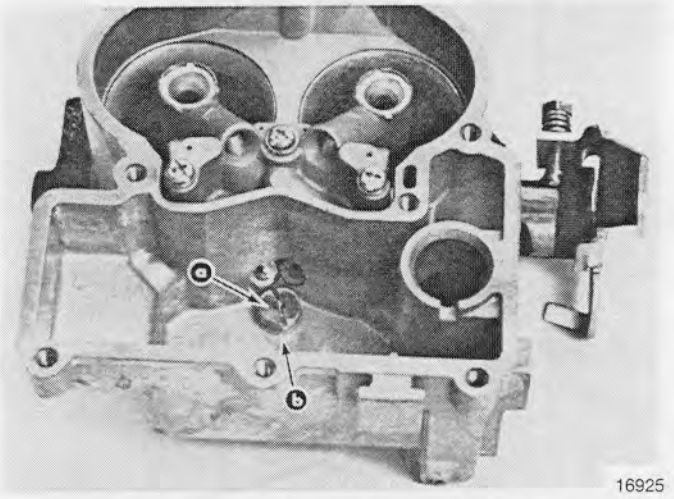
Float Bowl Assembly

1. Remove accelerator pump return spring from pump well. (Figure 14)
2. Carefully remove retainer clip, strainer, and check ball from pump well. (Figure 14)



a - Accelerator Pump Return Spring
b - Retainer Clip
c - Strainer
d - Check Ball
e - Pump Well

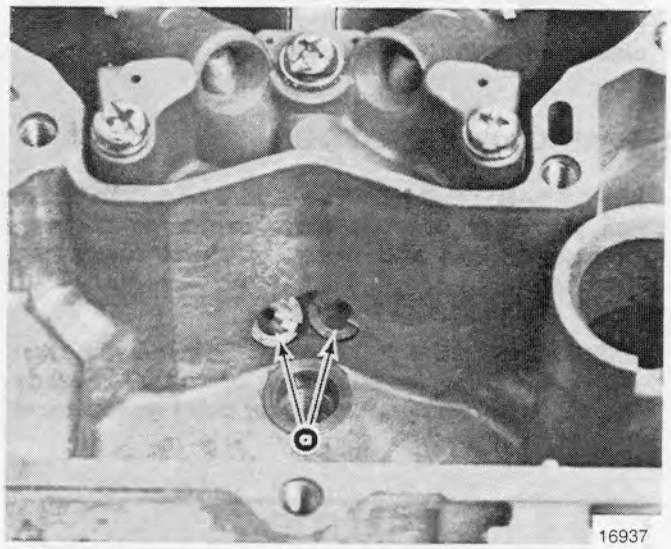
Figure 14. Removing Accelerator Pump Return Spring, Retainer Clip, Strainer, and Check Ball



a - Power Valve Assembly
b - Gasket

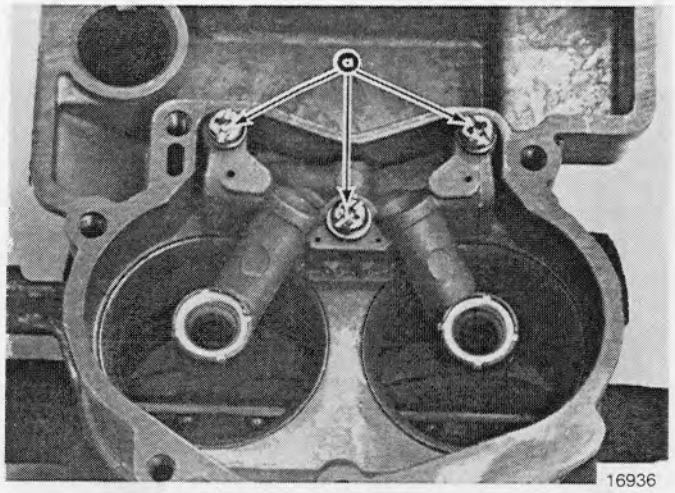
Figure 15. Removing Power Valve Assembly

3. Remove power valve assembly and gasket. (Figure 15)
4. Remove main metering jets and gaskets. (Figure 16)



a - Main Metering Jets - Gaskets Not Seen In Photo

Figure 16. Removing Main Metering Jets

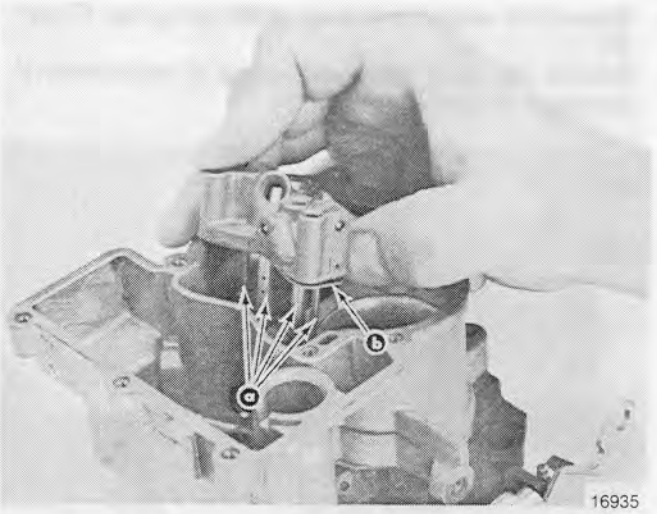


a - Screws/Lockwashers

Figure 17. Removing Venturi Cluster Attaching Screws

IMPORTANT: Use care when removing venturi cluster to prevent damaging brass tubes protruding from bottom of cluster. DO NOT REMOVE TUBES. These tubes are permanently pressed into the venturi cluster and are not replaceable.

5. Remove three venturi cluster screws (Figure 17), and carefully remove cluster and venturi gasket. (Figure 18)



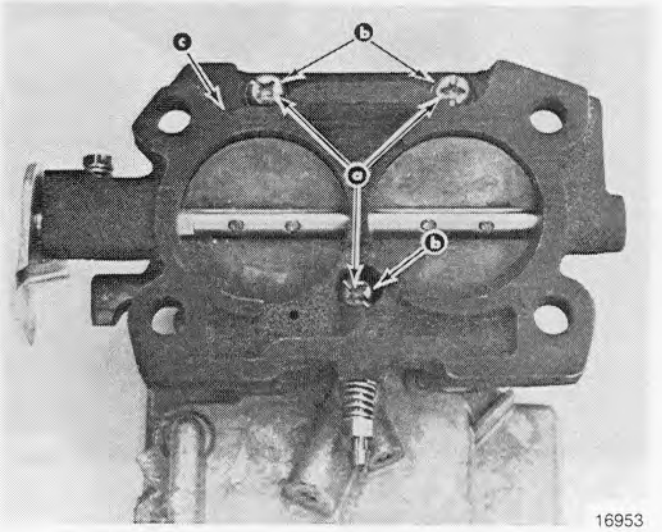
a - Venturi Cluster Brass Tubes
b - Gasket

Figure 18. Carefully Remove Venturi Clusters

Throttle Body Assembly

IMPORTANT: Use extreme care when handling throttle body, so as not to damage throttle valves.

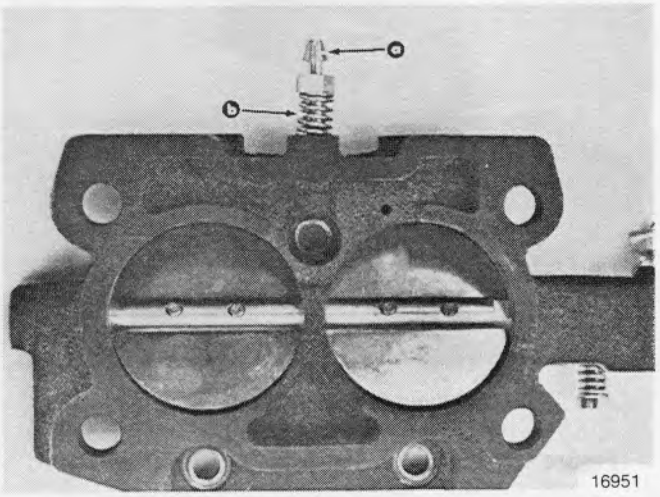
1. Place float bowl assembly upside down. Remove three throttle body assembly attaching screws and lockwashers, and remove throttle body and gasket from float bowl. (Figure 19)



a - Screws
b - Lockwashers
c - Throttle Body - Gasket Not Seen in Photo

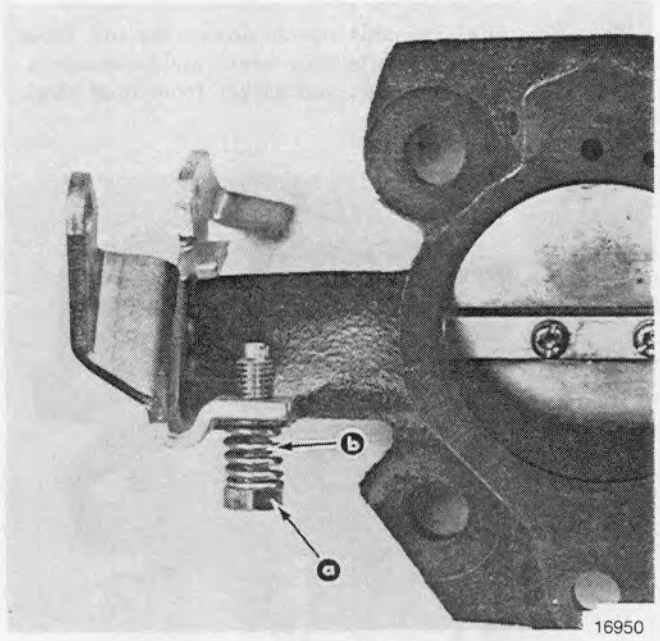
Figure 19. Separating Throttle Body From Float Bowl Assembly

2. Remove idle mixture adjusting needle and spring. (Figure 20)
3. Remove idle speed screw and spring, if replacement is necessary. (Figure 21)



a - Idle Mixture Adjusting Needle
b - Spring

Figure 20. Removing Idle Adjusting Needle and Spring



a - Idle Speed Screw
b - Spring

Figure 21. Removing Idle Speed Screw and Spring

IMPORTANT: DO NOT remove throttle valves. If any of the throttle body parts are found to be worn or damaged, complete throttle body assembly MUST BE replaced. Throttle body assembly can be cleaned in carburetor cleaner.

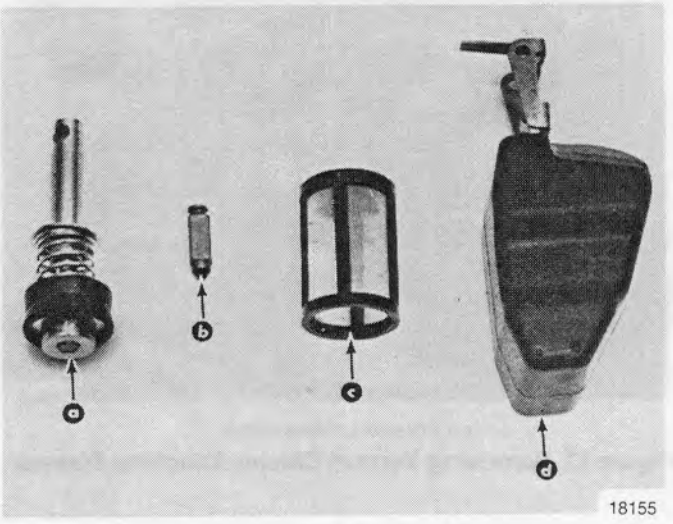
CLEANING and INSPECTION

IMPORTANT: DO NOT use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

⚠CAUTION

The float assembly, float needle, accelerator pump plunger, and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden, and/or distort.



a - Accelerator Pump Plunger
b - Float Needle
c - Fuel Filter
d - Float Assembly

Figure 22. Items Which MUST NOT BE Immersed in Carburetor Cleaner

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe-off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:
   a. **Float Needle and Seat:** If float needle or seat is worn or damaged, replace with a new needle and seat assembly.

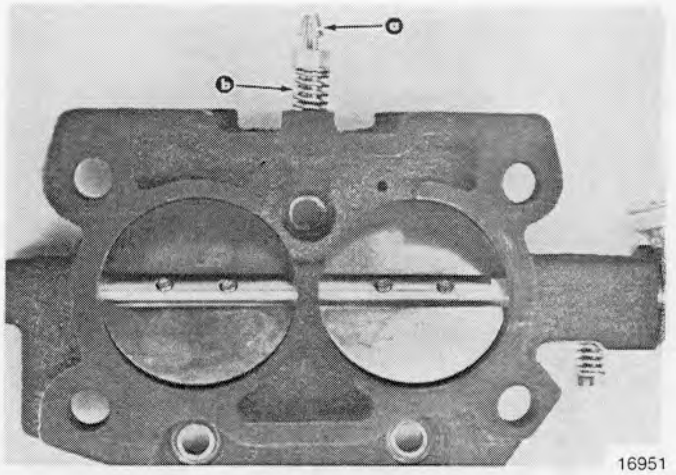
IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

   b. **Float Assembly and Hinge Pin:** Check pontoon density (to see if it is saturated with fuel), by comparing weight of float with specifications. If pontoon weight is high, float assembly must be replaced. Check hinge pin and holes for wear.
   c. **Fuel and Air Passages:** Passages must be perfectly clean for proper carburetor operation.
   d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring (on pump assembly) and return spring.
   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.
   f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle must be replaced.
   g. **Levers and Linkages:** Check levers, links and rods for wear.
   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding thru entire operating range, making sure valve opens and closes completely. Throttle body assembly must be replaced if throttle valve and shaft are worn or damaged.
   i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding thru entire operating range, making sure valve opens and closes completely. Air horn assembly must be replaced if choke valve and shaft and lever assembly are worn or damaged.
   j. **Inspect Casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

REASSEMBLY

Throttle Body Assembly

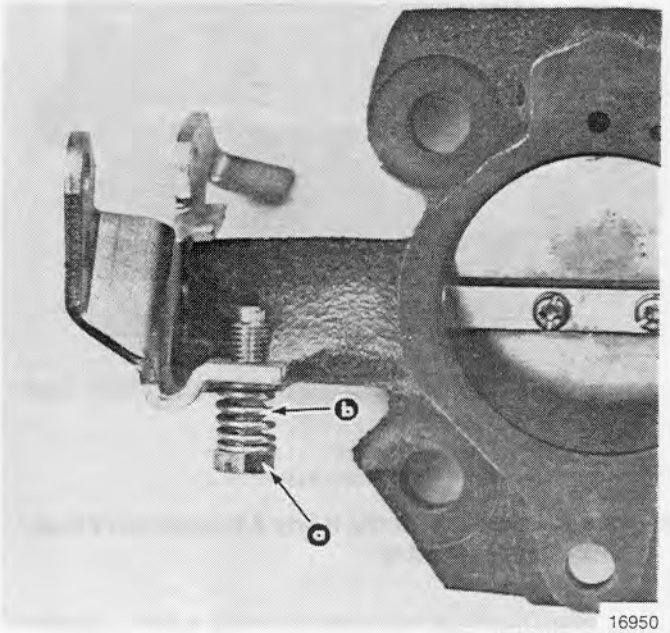
IMPORTANT: DO NOT force idle mixture needle against seat as damage to needle and/or seat will result.



a - Idle Mixture Needle
b - Spring

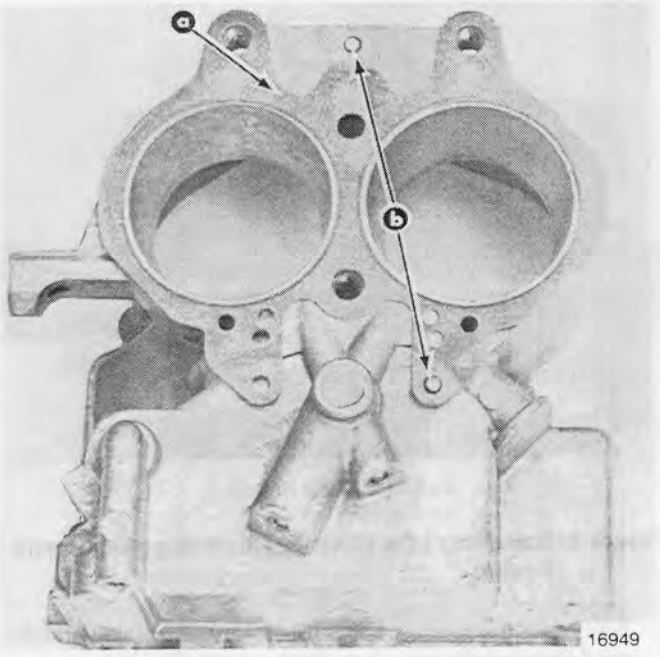
Figure 1. Installing Idle Mixture Adjusting Needle and Spring

1. Screw idle mixture needle (and spring) into throttle body until they lightly seat; then, back out needle 1¼ turns as a preliminary idle mixture setting. (Figure 1) Final adjustment will be made with engine running. Refer to "Adjustments".
2. Thread idle speed screw and spring into throttle lever. (Figure 2)
3. Turn float bowl assembly upside-down and place new throttle body gasket on bowl, making sure gasket is properly positioned on locating dowel. (Figure 3)



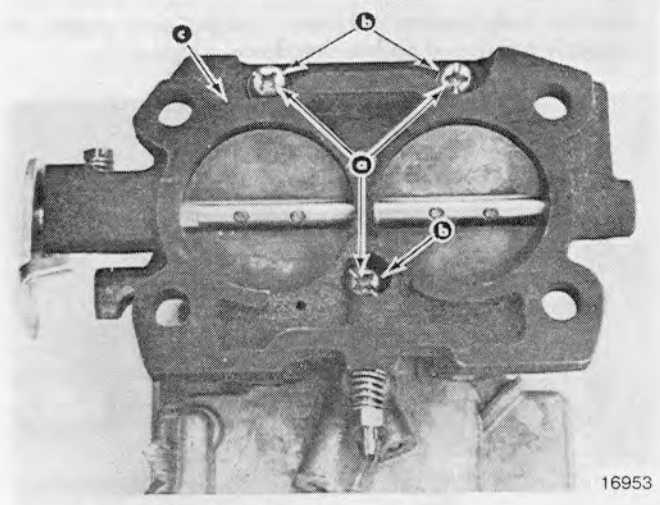
a - Idle Speed Screw
b - Spring

Figure 2. Installing Idle Speed Screw



a - Throttle Body Gasket
b - Locating Dowel

Figure 3. Throttle Body Gasket Properly Positioned on Float Bowl Assembly



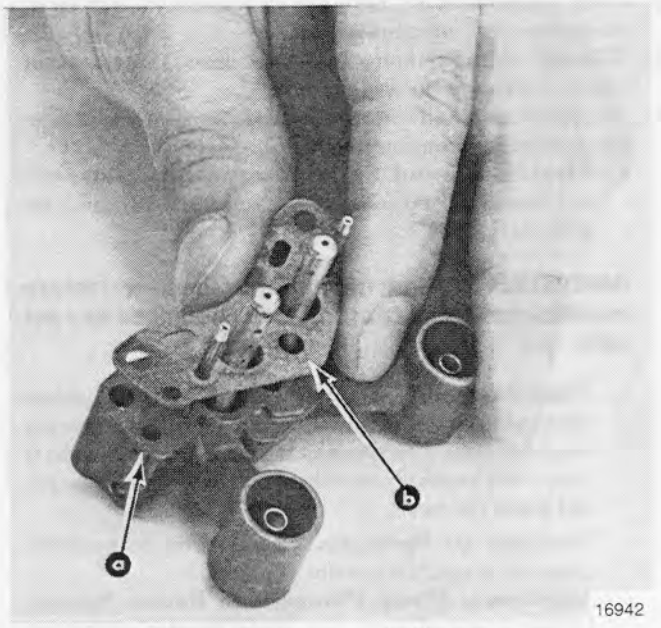
a - Screws
b - Lockwashers
c - Throttle Body Assembly

Figure 4. Installing Throttle Body Assembly on Float Bowl Assembly

4. Install throttle body assembly on float bowl assembly, making sure that screw holes in gasket line up with screw holes in throttle body. (Figure 4) Tighten screws evenly and securely.

Float Bowl Assembly

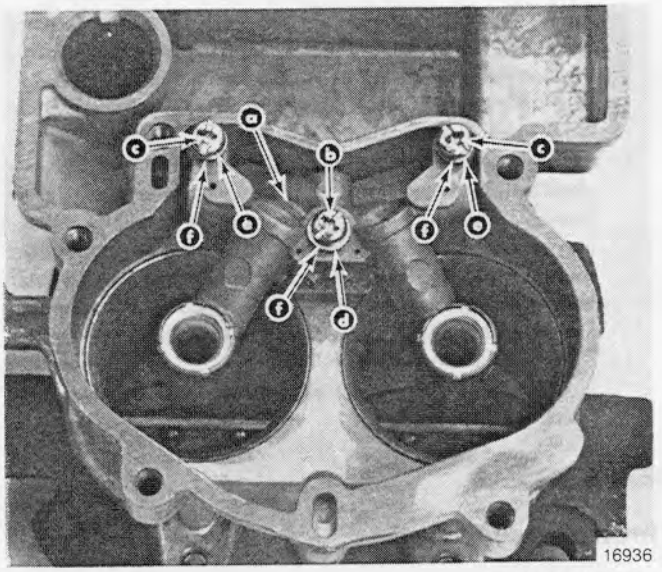
IMPORTANT: Place float bowl and throttle assemblies in a holding fixture to prevent throttle valves from being damaged.



a - Venturi Cluster b - Gasket

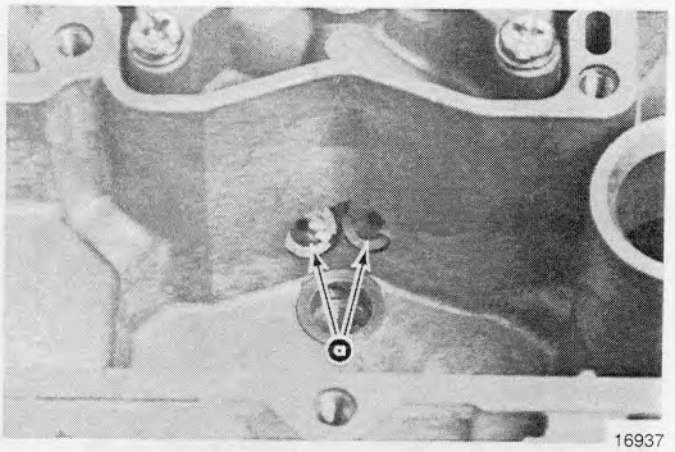
Figure 5. Placing Gasket on Venturi Cluster

1. Place new gasket over venturi cluster brass tubes. (Figure 5) Carefully, install venturi cluster in float bowl, using three screws, gaskets and lockwashers as shown in Figure 6. Tighten screws evenly and securely.



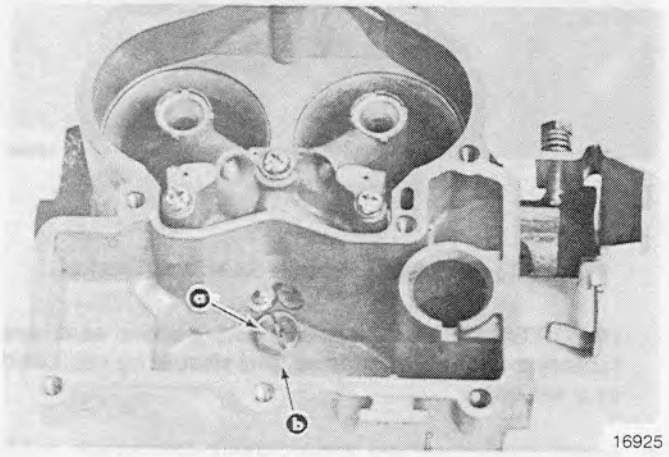
a - Venturi Cluster
b - Center Screw (With Smooth Shank)
c - Outer Screws
d - Fiber Washer
e - Lockwashers
f - Metal Gaskets

Figure 6. Installing Venturi Cluster



a -Main Metering Jets

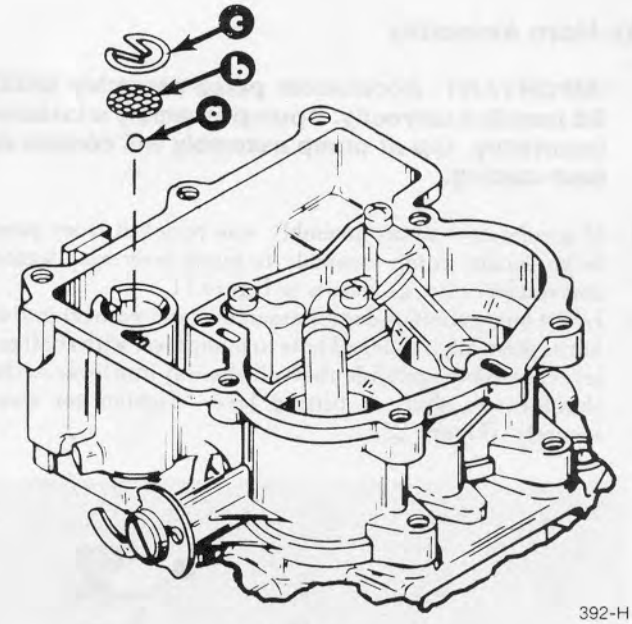
Figure 7. Installing Main Metering Jets



a - Power Valve Assembly
b - Gasket

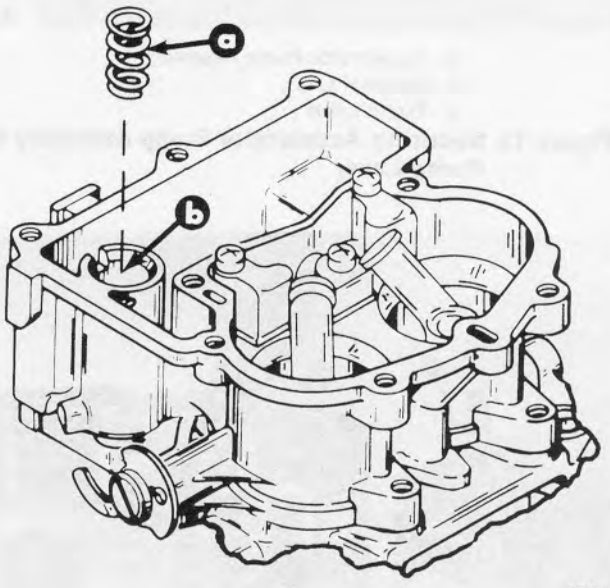
Figure 8. Installing Power Valve Assembly

2. Install main metering jets and gaskets in bottom of float bowl assembly; tighten jets securely. (Figure 7)
3. Install power valve assembly and gasket in bottom of float bowl assembly and tighten securely. (Figure 8)
4. Place check ball in pump well; then, install strainer and retainer clip. (Figure 9) DO NOT use pliers to install clip.
5. Place accelerator pump return spring in pump well. (Figure 10)



a - Check Ball
b - Strainer
c - Retainer Clip

Figure 9. Installing Check Ball, Strainer, and Retainer Clip



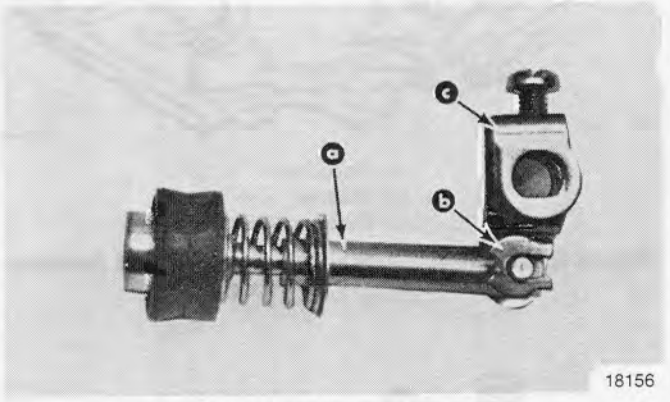
a - Accelerator Pump Return Spring
b - Pump Well

Figure 10. Installing Accelerator Pump

Air Horn Assembly

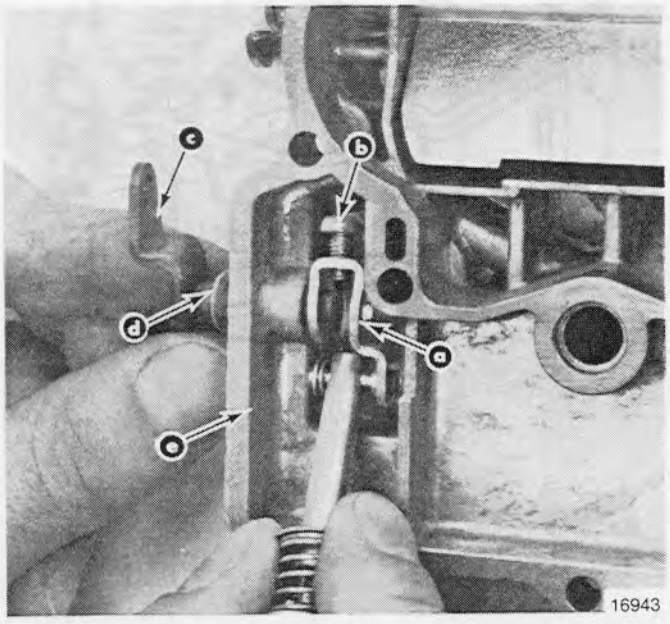
IMPORTANT: Accelerator pump assembly MUST BE installed correctly. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

1. If accelerator pump assembly was removed from pump lever, secure pump assembly to pump lever with washer and retainer clip, as shown in Figure 11.
2. Insert pump shaft and lever assembly (and washer) into air horn; then, align indexed hole in pump lever with shaft and lever assembly and slide shaft all-the-way into lever so that shoulder on shaft is hitting lever. Tighten set screw securely. (Figure 12)



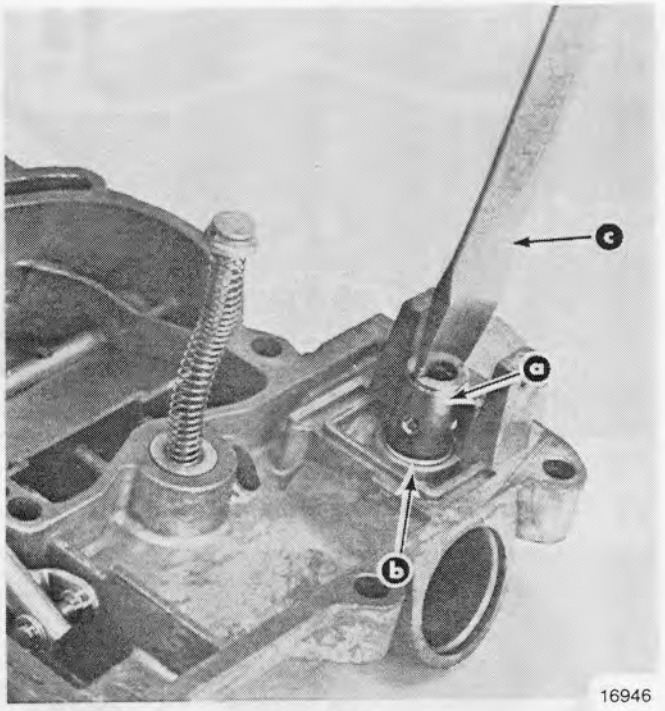
a - Accelerator Pump Assembly
b - Retainer Clip
c - Pump Lever

Figure 11. Securing Accelerator Pump Assembly to Pump Lever



a - Pump Lever
b - Set Screw
c - Pump Shaft and Lever Assembly
d - Washer
e - Air Horn

Figure 12. Installing Accelerator Pump Assembly and Pump Shaft and Lever Assembly

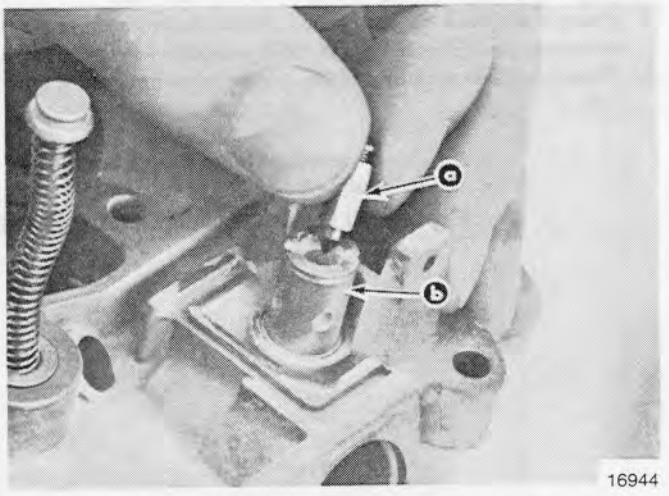


a - Needle Seat
b - Gasket
c - Screwdriver

Figure 13. Installing Needle Seat and Gasket

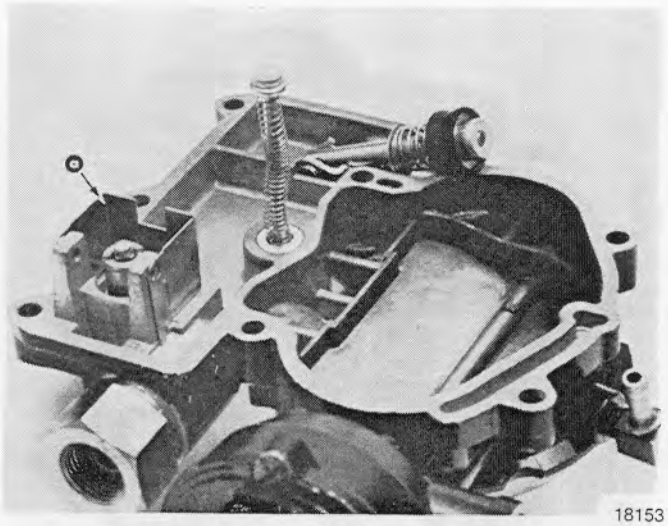
IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

3. Install needle seat and gasket, using appropriate width screwdriver. (Figure 13)
4. Place needle assembly in needle seat. (Figure 14)
5. Install baffle. (Figure 15)
6. Place new gasket on air horn. (Figure 16)
7. Install float assembly and hinge pin. (Figure 17) Pivot float assembly up-and-down on hinge pin to ensure it moves freely.



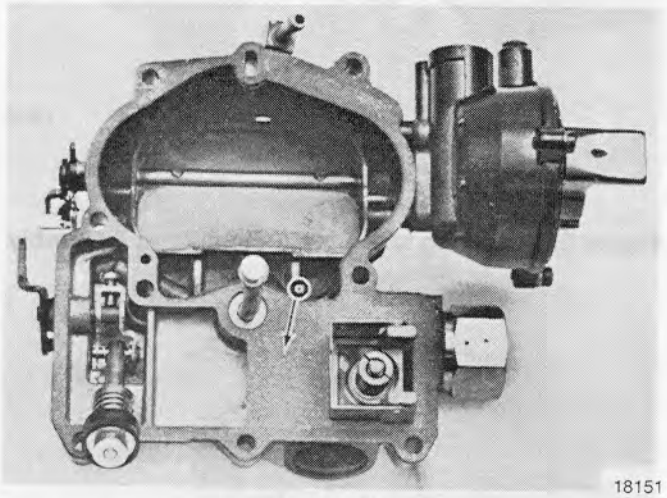
a - Needle Assembly
b - Needle Seat

Figure 14. Installing Needle Assembly



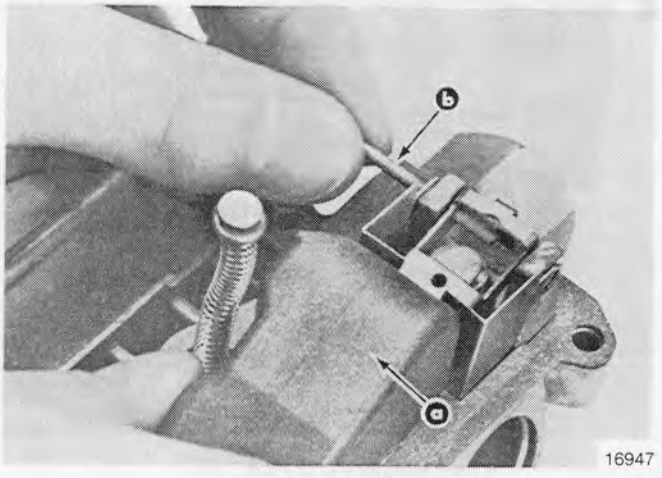
a - Baffle

Figure 15. Installing Baffle



a - Gasket

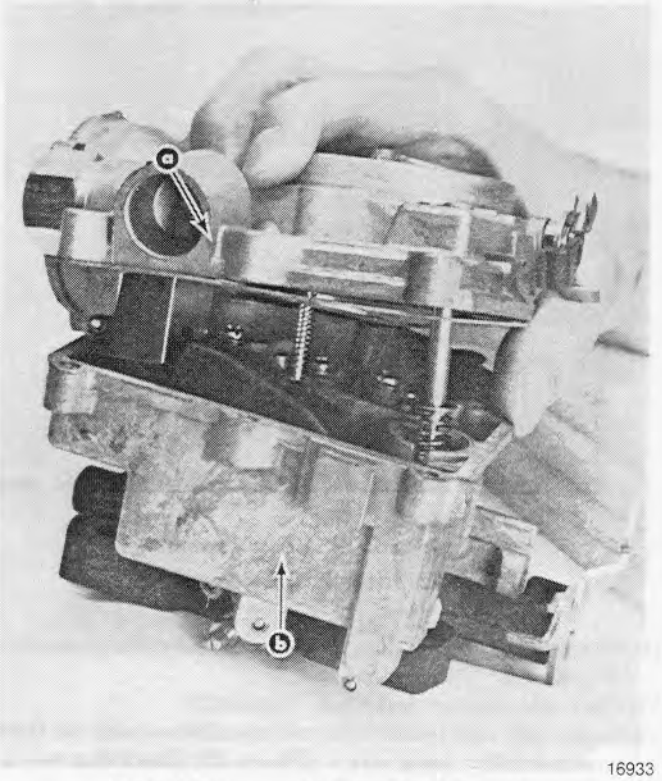
Figure 16. Installing Air Horn Gasket



a - Float Assembly
b - Float Hinge Pin

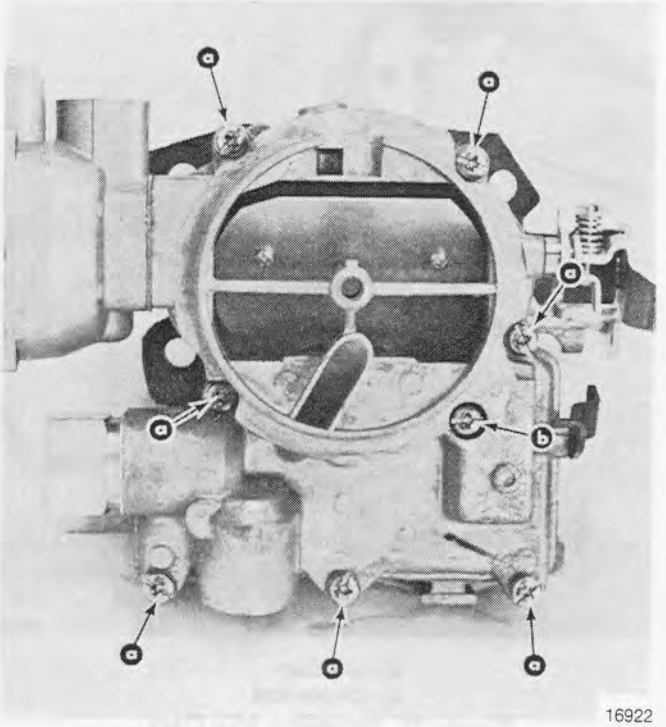
Figure 17. Installing Float Assembly and Hinge Pin

8. Place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn straight down to install. (Figure 18)
9. Install seven short and one long air horn attaching screws. Tighten screws evenly and securely. (Figure 19)



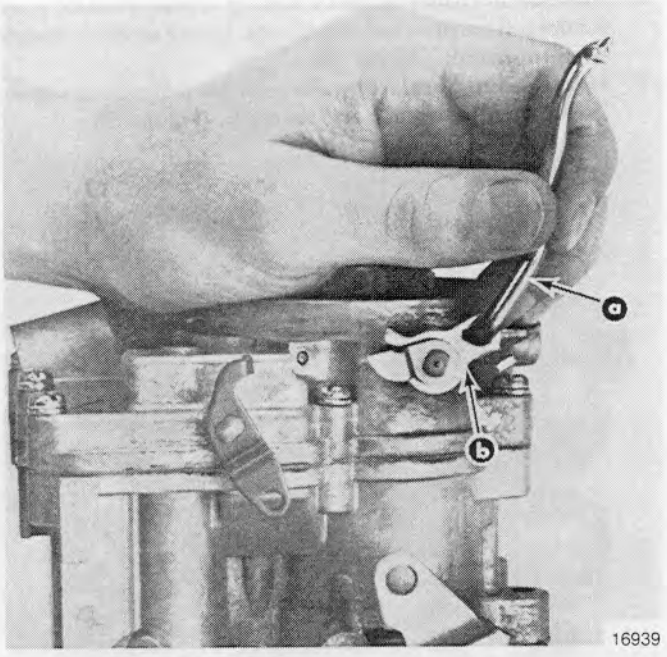
a - Air Horn b - Float Bowl Assembly

Figure 18. Carefully Installing Air Horn



a - Seven Short Screws b - One Long Screw

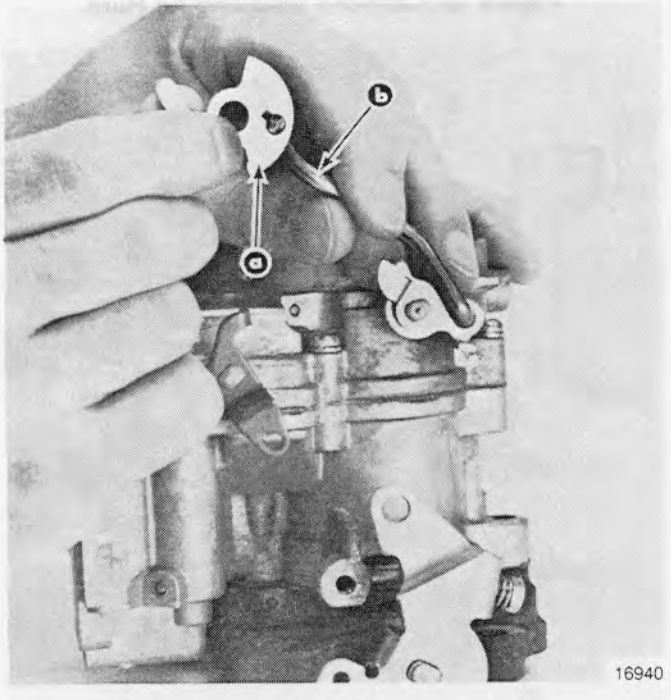
Figure 19. Installing Air Horn Attaching Screws



a - Choke Rod
b - Choke Lever and Collar Assembly

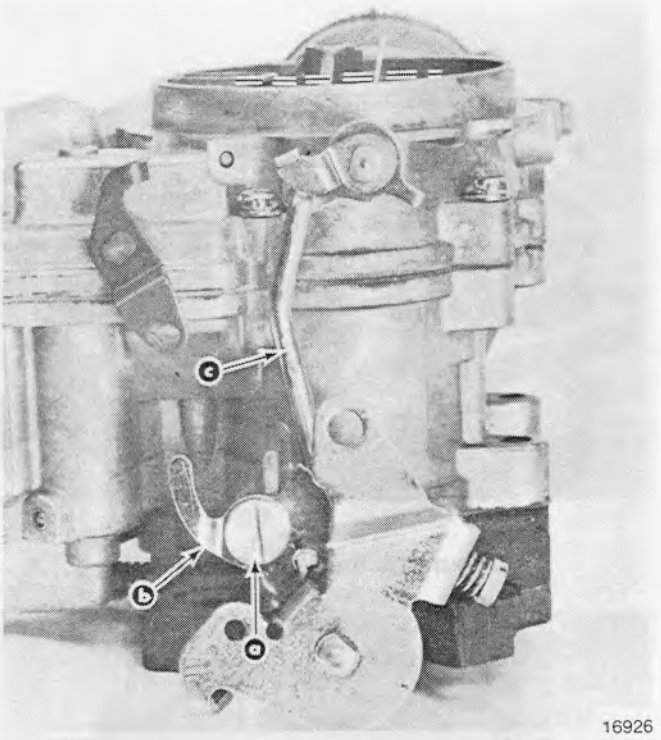
Figure 20. Installing Choke Rod

10. Place end of choke rod in choke lever and collar assembly. (Figure 20)
11. Place idle cam on choke rod. (Figure 21)
12. Secure idle cam (with choke rod installed on cam) on float bowl assembly, using screw. (Figure 22) Check that cam is free to move without binding.



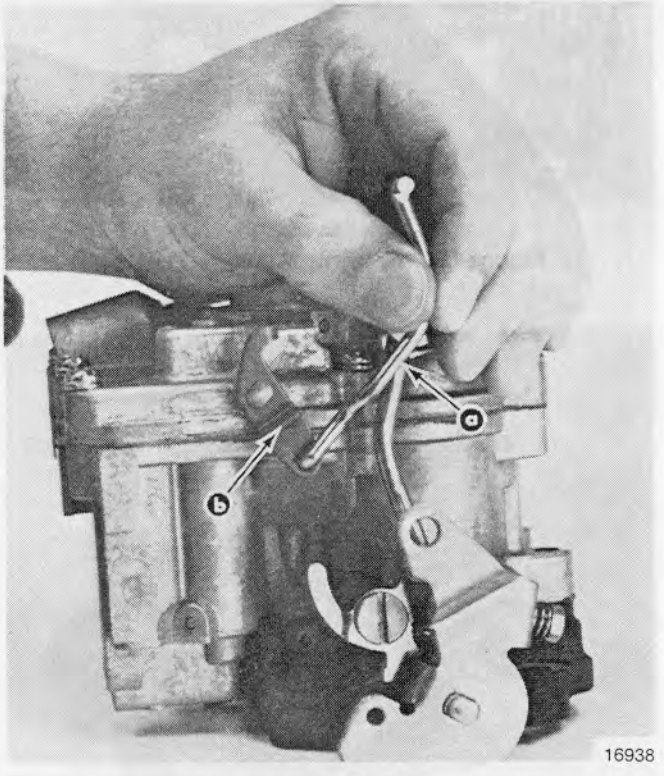
a - Idle Cam
b - Choke Rod

Figure 21. Installing Idle Cam



a - Screw
b - Idle Cam
c - Choke Rod

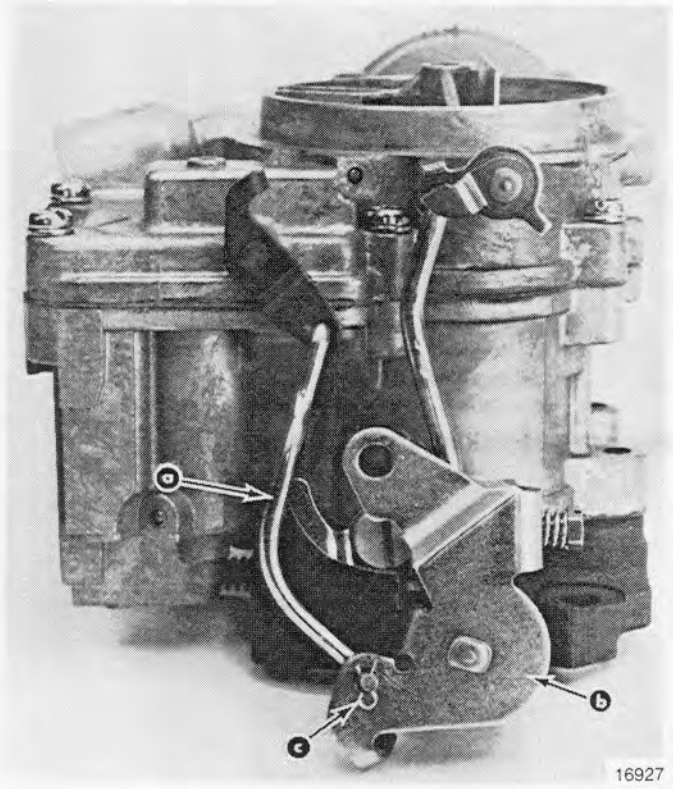
Figure 22. Securing Idle Cam to Float Bowl Assembly



a - Accelerator Pump Rod
b - Pump Shaft and Lever Assembly

Figure 23. Installing Accelerator Pump Rod

13. Place accelerator pump rod (end with ear) in hole in pump shaft and lever assembly. (Figure 23)
14. Insert remaining end of accelerator pump rod into hole in throttle lever and secure with retainer clip. (Figure 24)



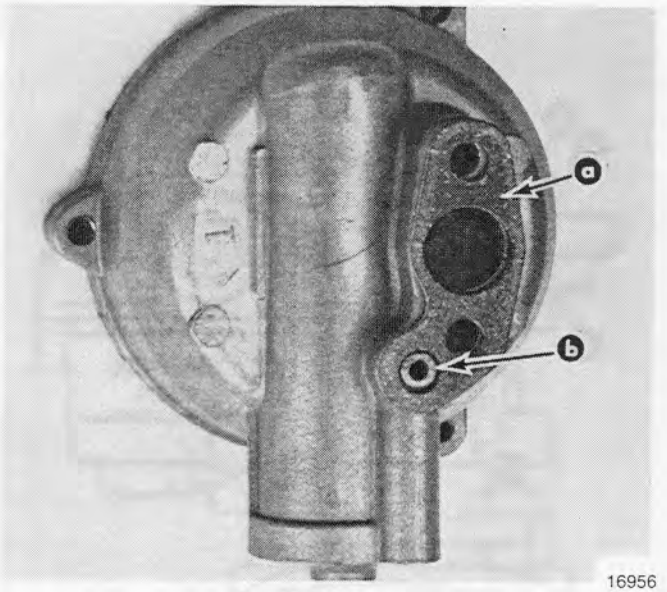
a - Accelerator Pump Rod
b - Throttle Lever
c - Retainer Clip

Figure 24. Securing Accelerator Pump Rod to Throttle Lever

Choke Housing Assembly

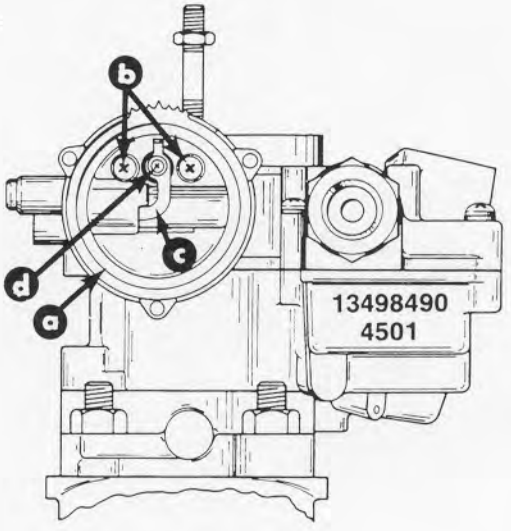
IMPORTANT: Not all MerCarb carburetors are equipped with choke housing gasket. This gasket is not necessary for choke housing installation; therefore, if replacement gasket is not available, choke housing may be installed on air horn assembly without gasket.

1. Place new choke housing gasket (if equipped) in position on air horn making sure that, when installing choke housing assembly, locating pin on housing inserts into hole in gasket. (Figure 25)
2. Secure choke housing assembly to air horn with two attaching screws. (Figure 26) Tighten screws securely.
3. Fasten choke lever to choke shaft assembly with screw, as shown in Figure 26.
4. Place choke cover on choke housing. Be sure hook on end of heating coil engages with choke lever. Rotate choke cover until alignment marks (made at disassembly) line up.



a - Gasket
b - Choke Housing Assembly Gasket Locating Pin

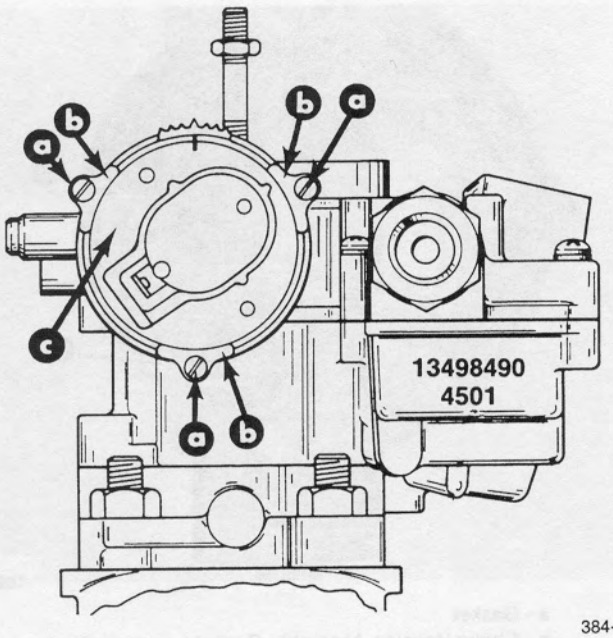
Figure 25. Installing Choke Housing Assembly Gasket



a - Choke Housing Assembly
b - Choke Housing Assembly Attaching Screws
c - Choke Lever
d - Choke Lever Screw

Figure 26. Installing Choke Housing Assembly and Choke Lever Assembly to Air Horn

5. Secure choke cover with three screws and retainers (Figure 27), being sure ground terminal is fastened under bottom screw.



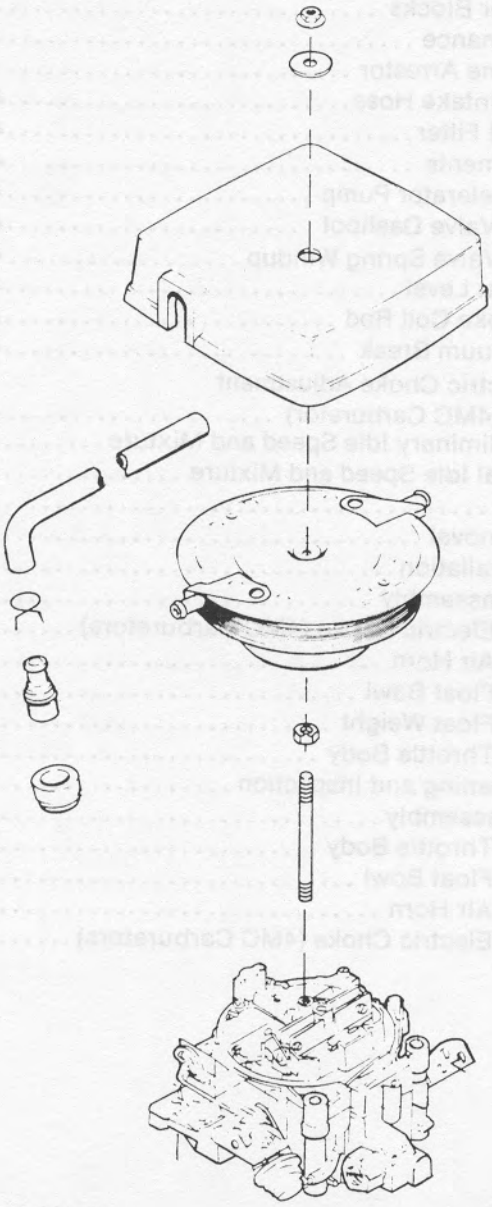
384-H

a - Screws
b - Retainer
c - Choke Cover

Figure 27. Installing Choke Cover

SECTION 4 - FUEL SYSTEM

PART D - ROCHESTER 4 BARREL



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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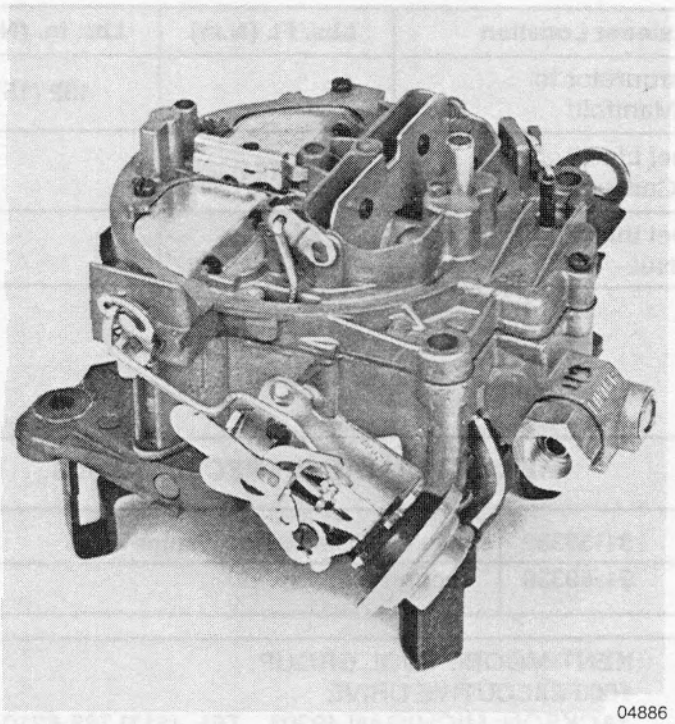
IDENTIFICATION



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REPLACEMENT PARTS WARNING

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Carburetor to Manifold		132 (15)
Fuel Line To Carburetor	18 (24)	
Fuel Inlet Filter Nut	18 (24)	

TOOLS

MERCURY MARINE SPECIAL TOOLS	
91-36392	Universal Carburetor Gauge
91-59339	Tachometer

KENT-MOORE TOOL GROUP 1600 EXECUTIVE DRIVE JACKSON, MICHIGAN 49203 TEL. (517) 788-6210	
J9789-118	Carburetor Stand
J22769	Needle Valve Seat Remover

WAGNER INSTRUMENTS P.O. BOX 1217 GREENWICH, CT. 06836 (203) 869-9681	
Model G.D. 150	Gram Scale (With Round Tip)

BORROUGHS TOOL & EQUIPMENT CORP. 2429 N. BURDICK ST. KALAMAZOO, MICH. 49007 (616) 345-5163	
BT-8128 B	Float Scale
BT-8420 A	Float Level Gauge

TORX® SCREWDRIVERS

Later Rochester Quadrajet carburetors will have a "star" shaped socket in the head of the screw. A TORX® screwdriver must be used on this type of screw. The three sizes used are #9, #20 and #25.

SPECIFICATIONS

Model (Serial Number)	Carb Type (Note 1)	Mercury No. (Manufacturer No.)	Primary Jet Size	Primary (Secondary) Metering Rods	Hanger (Note 2)
MCM 228 (5069430 and Below)	Rochester 4MV	1347-6427 (17057282)	.069 In.	.042 In. (DE)	F
MCM 228 (5069431-6021783)	Rochester 4MV	1347-7361 (17059292)	.069 In.	.042 In. (DE)	F
MCM 228R (6021784 and Above)	Rochester 4MV	1347-8296 (17080565)	.069 In.	.042 In. (DE)	F
MIE 228 (5069430 and Below)	Rochester 4MV	1347-6438 (17057283)	.067 In.	.036 In. (DL)	K
MIE 228 (5067431-6040745)	Rochester MV	1347-7364 (17059291)	.067 In.	.036 In. (DL)	K
MIE 228 (6040746 and Above)	Rochester 4MV	1347-8290 (17080564)	.067 In.	.036 In. (DL)	K
MIE 230 (All)	Rochester 4MV	1347-8290 (17080564)	.067 In.	.036 In. (DL)	K
MIE 255 (4924564 and Below)	Rochester 4MV	1347-5732 (17044291)	.069 In.	.036 In. (CH)	P
MIE 255 (4924565-5195908)	Rochester 4MV	1347-7062 (17057295)	.069 In.	.036 In. (CH)	P
MIE 255 (5195909-5907067)	Rochester 4MV	1347-7365 (17059289)	.069 In.	.036 In. (CH)	P
MIE 255 (5907068 and Above)	Rochester 4MV	1347-8289 (17080562)	.069 In.	.036 In. (CH)	P
MCM 260 (5060805 and Below)	Rochester 4MV	1347-6492 (17057298)	.068 In.	.041 In. (DE)	D
MCM 260 (5060806-6024393)	Rochester 4MV	1347-7362 (17059288)	.068 In.	.041 In. (DW-DE)	D

NOTES:

1. Rochester Quadrajets are 4MV or 4MC type. The "V" or "C" designates choke type, NOT bore size. This information supercedes all previous service bulletins and service information.
2. Hanger size may vary from this chart. Install same size hanger which was removed from the carburetor.

Model (Serial Number)	Carb Type (Note 1)	Mercury No. (Manufacturer No.)	Primary Jet Size	Primary (Secondary) Metering Rods	Hanger (Note 2)
MCM 260R (6024394 and Up)	Rochester 4MV	1347-8292 (17080561)	.068 In.	.041 In. (DW-DE)	D
MIE 260 (All)	Rochester 4MV	1347-8289 (17080562)	.069 In.	.036 In. (CH)	P
MCM 330 (5027230 and Below)	Rochester 4MV	1347-6493 (17057287)	.069 In.	.042 In. (DB)	F
MCM 330 (5027231-6083144)	Rochester 4MV	1347-7363 (17059290)	.069 In.	.042 In. (DB)	F
MCM 330 (B-W) (6083145 and Above)	Rochester 4MV	1347-8291 (17080563)	.069 In.	.042 In. (DB)	F
MIE 330 (5226384 and Below)	Rochester 4MV	1347-6493 (17057287)	.069 In.	.042 In. (DB)	F
MIE 330 (5226385 and Above)	Rochester 4MV	1347-7366 (17059287)	.069 In.	.042 In. (CL)	F
MCM 370/400/400 Cyclone (All)	Rochester 4MV	1347-7298 (17059280)	.068 In.	.041 In. (DA)	F
MCM 488R (All)	Rochester 4MC	1347-8460 (17081299)	.066 In.	.036 In. (CZ-DE)	K
MIE 340 (All)	Rochester 4MV	1347-8288 (17080560)	.069 In.	.042 In. (CL)	F

NOTES:

1. Rochester Quadrajets are 4MV or 4MC type. The "V" or "C" designates choke type, NOT bore size. This information supercedes all previous service bulletins and service information.
2. Hanger size may vary from this chart. Install same size hanger which was removed from the carburetor.

UNIT OF MEASUREMENT
in. (mm)

MCM CARBURETOR ADJUSTMENT SPECIFICATIONS (Note 1)

Engine Model	MCM 228	MCM 260	MCM 330	MCM 370/400 400 Cyclone	MCM 488
Make & Model	Rochester 4MV				Rochester 4MC
Carb. Manufacturer Number	17059292 17057282 17080565	17059288 17057298 17080561	17059290 17057287 17080563	17059288 17059280	17081299
Float Level	15/64 (5.9)				(Note 2)
Pump Rod Hole Location	Inner				
Accelerator Pump (Note 3)	23/64 (9.1)				
Air Valve Dash Pot (Air Valve Rod)	.025 (.64)				
Vacuum Break	.080 [5/64 (2.0)]				.190 [3/16 (4.8)]
Air Valve Spring Wind Up	3/8 Turn 70-90 Gr.	1/2 Turn 70-90 Gr.	1/2 Turn 80-95 Gr.	5/8 Turn 70-90 Gr.	1/4 Turn 40-50 Gr.
Choke Coil Rod (Note 5)	Top of Rod Even With Bottom of Hole				(Note 4)
Idle Mixture Screw Preliminary Setting	2-3 Turns				
Float Weight (Max)	9.88 Gr.				

NOTES:
1. All measurements are ± 1/64" (0.4mm). Information contained in this chart supercedes all service bulletins printed in 1984 and earlier.
2. If fuel inlet needle is spring loaded: Float lever must just touch needle ball. Do not push down on ball: float level is 1/4" (6.4mm). Solid needle models: float level is 3/8" (9mm).
3. Accelerator pump measurement taken from flame arrestor surface to pump stem with throttle plates closed.
4. Refer to figure 16 or 17 in 'Adjustments" in this section for electric choke adjustment on the 4MC carburetor.
5. Choke valve must be closed, choke rod in bottom of choke lever slot, and choke coil rod pushed down to end of travel.

UNIT OF MEASUREMENT
in. (mm)

MIE CARBURETOR ADJUSTMENT SPECIFICATIONS (Note 1)

Engine Model	MIE 228	MIE 230	MIE 255	MIE 260	MIE 330	MIE 340
Make & Model	Rochester 4MV					
Carb. Manufacturer Number	17059291 17057283 17080564	17080564	17059289 17044291 17080562 17057295	17080562	17059287 17057287	17080560
Float Level	15/64 (5.9)					
Pump Rod Hole Location	Inner					
Accelerator Pump (Note 2)	23/64 (9.1)					
Air Valve Dash Pot (Air Valve Rod)	.025 (.64)					
Vacuum Break	.080 [5/64 (2.0)]					
Air Valve Spring Wind Up	3/8 Turn 75-85 Gr.	3/8 Turn 60-75 Gr.	3/8 Turn 75-85 Gr.	3/8 Turn 70-90 Gr.	3/4 Turn 80-95 Gr.	
Choke Coil Rod (Note 3)	Top of Rod Even With Bottom of Hole					
Idle Mixture Screw Preliminary Setting	2-3 Turns					
Float Weight (Max)	9.88 Gr.					

NOTES: 1. All measurements are ± 1/64" (.4mm). Information contained in this chart supercedes all service bulletins printed in 1984 and earlier.
2. Accelerator pump measurement taken from flame arrestor surface to pump stem with throttle plates closed.
3. Choke valve must be closed, choke rod in bottom of choke lever slot, and choke coil rod pushed down to end of travel.

DESCRIPTION

The 4MV and 4MC Quadrajets are 4 barrel, 2 stage carburetors. Both the 4MV and 4MC are of the same design, the only real difference being in the choke operation. The 4MV has a manifold mounted choke thermostat housing, and a link rod attaching the thermostat spring to the carburetor choke linkage. The 4 MC has the choke thermostat housing mounted directly on the airhorn of the carburetor. The thermostat spring is hooked directly to the carburetor choke linkage.

The Quadrajet carburetor has 2 stages of operation. The primary (fuel inlet) side has small bores with a triple venturi set-up equipped with plain tube nozzles. Its metering principles are similar to the most plain tube carburetors which use the venturi principle. The triple venturi stack up, plus smaller primary bores, give a more stable and finer fuel control in idle and economy ranges of operation. Fuel metering in primary side is accomplished with tapered metering rods positioned by a manifold vacuum responsive piston.

The secondary side has 2 very large bores which have greatly increased air capacity to meet present day and future engine demands. The air valve principle is used in the secondary side for metering control and supplements fuel flow from the primary bores.

Using the air valve principle, fuel is metered in direct proportion to air passing thru the secondary bores.

The fuel reservoir is centrally located to avoid problems of fuel slosh causing engine turn cut-out and delayed fuel to carburetor bores. The float system uses a single float pontoon for ease in servicing the unit.

PRECAUTIONS

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION

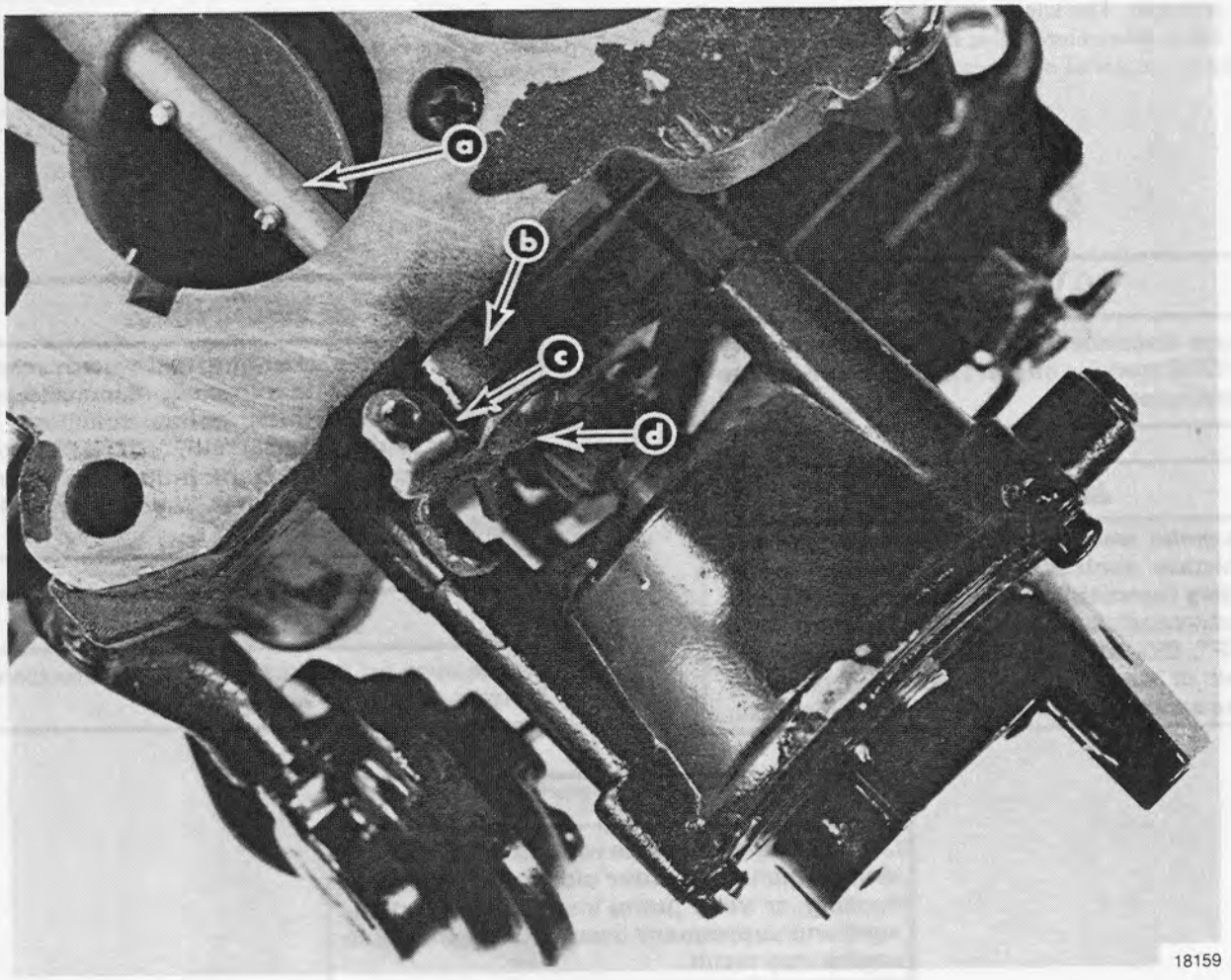
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

IMPORTANT SERVICE INFORMATION

4MC CARBURETOR MERCURY NUMBER, 1347-9142 (Rochester Number 17083522)

IMPORTANT: The MCM 190MR 4MC carburetor 17083522 supercedes the original 488R 4MC carburetor 17081299. There were several changes made on the 17083522 carburetor that must be addressed.

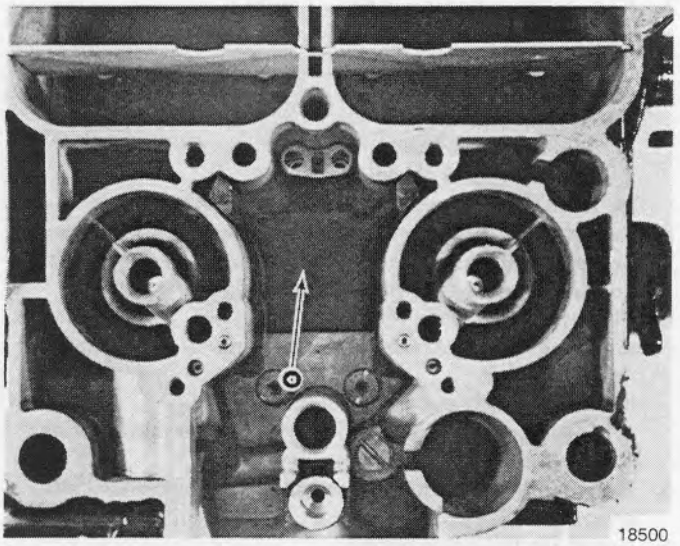
1. Modifying (17083522) Rochester carburetor for use on MCM 488.
   a. Before installing the (17083522) carburetor on MCM 488 remove and discard the choke pull-off lever, spacer and screw as shown in Figure 1. These parts must be removed because they will hit the 10° wedge when installing the carburetor.



a - Throttle Shaft
b - Spacer
c - Lever
d - Screw
— Remove and Discard

Figure 1. Modifying 17083522 Carburetor

2. The 17083522 Rochester carburetor has a nozzle deflector installed in the float bowl (Figure 2)



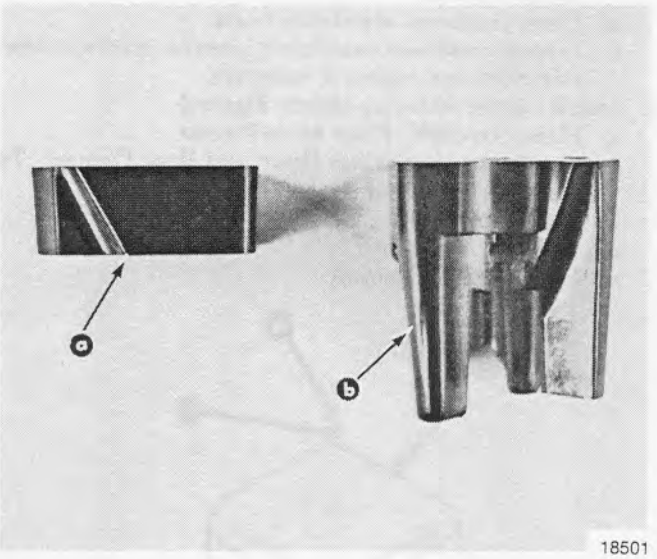
a - Nozzle Deflector

Figure 2. Nozzle Deflector Installed

IMPORTANT: When installing the 17083522 Rochester carburetor on a 488R with a 10° wedge the nozzle deflector can be used.

FILLER BLOCKS

1. There are 2 types of filler blocks used. Refer to Figure 3.



a - Short Filler Block Used on All 4MV V-8 Carburetors
b - Long Filler Block Used on 4MC 488R Carburetors

Figure 3. Types of Filler Blocks

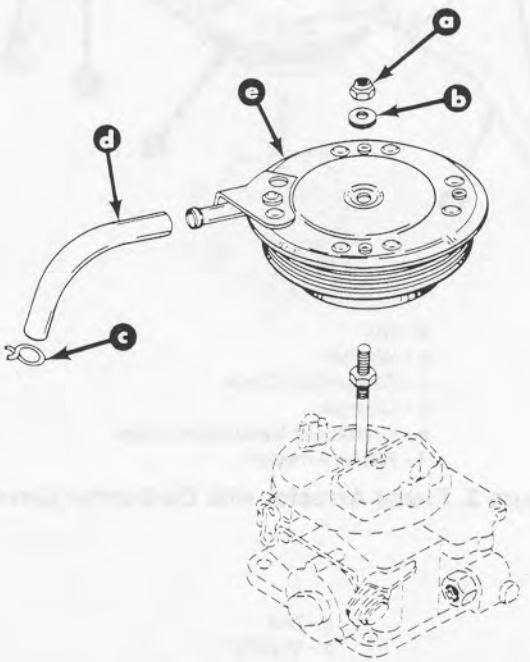
MAINTENANCE

FLAME ARRESTOR

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

IMPORTANT: There has been 3 styles of Flame Arrestors used on the Quadrajet carburetor. The 3 styles are depicted in Figures 1, 2, or 3. Locate the style you are servicing and follow proper service instructions.

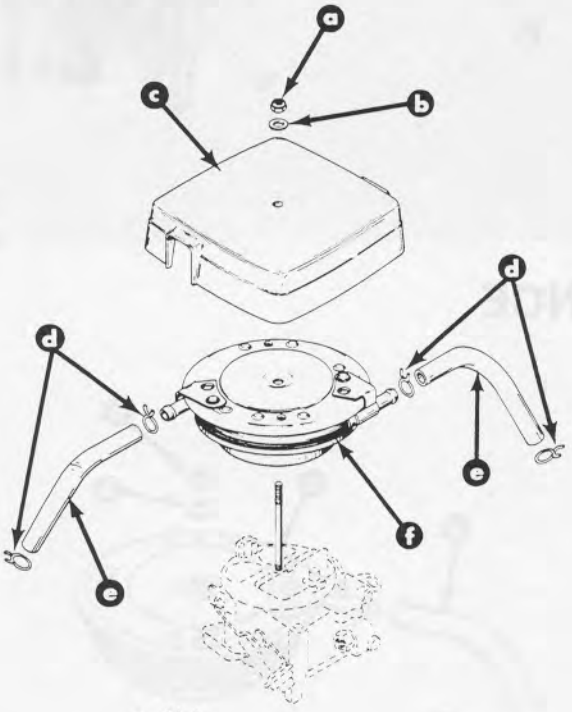
1. Remove (in the following order): Figure 1
   a. Nut
   b. Sealing Washer
   c. Hose Clamp(s) and Crankcase Ventilation Hose(s)
   d. Flame Arrestor - Lift from carburetor
2. Clean and Inspect:
   a. Clean flame arrestor by blowing it out with compressed air.
   b. Clean crankcase ventilation hose
   c. Inspect crankcase ventilation hose for cracks or deterioration, and replace if neccessry.
3. Install (in the following order): Figure 1
   a. Flame Arrestodr - Place on Carburetor
   b. Crankcase Ventilation Hose(s) and Hose Clamp(s)
   c. Sealing Washer
   d. Nut - Tighten Securely



a - Nut
b - Washer
c - Clamps
d - Crankcase Ventilation Hoses(s)
e - Flame Arrestor

Figure 1. Flame Arrestor Only

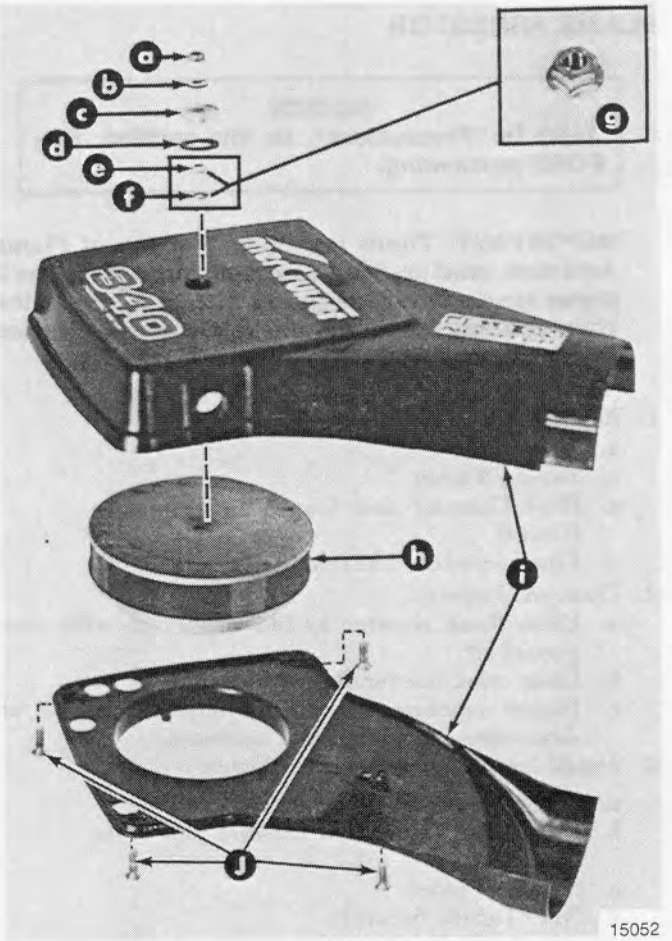
1. Remove (in the following order): Figure 2
   a. Nut
   b. Sealing Washer
   c. Carburetor Cover
   d. Hose Clamps and Crankcase Ventilation Hoses - From Flame Arrestor and Rocker Arm Covers
   e. Flame Arrestor - Lift from Carburetor
2. Clean and Inspect:
   a. Clean flame arrestor in solvent and blow dry with compressed air
   b. Clean crankcase ventilation hoses
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.
3. Install (in the following order): Figure 2
   a. Flame Arrestor - Place on carburetor
   b. Crankcase Ventilation Hoses and Hose Clamps - To Flame Arrestor and Rocker Arm Covers
   c. Carburetor Cover
   d. Sealing Washer
   e. Nut - Tighten Securely.



a - Nut
b - Washer
c - Carburetor Cover
d - Clamps
e - Crankcase Ventilation Hoses
f - Flame Arrestor

Figure 2. Flame Arrestor with Carburetor Cover

1. Before removing Air Silencer assembly, loosen clamp and remove air intake hose from air silencer.
2. Remove (in following order): Figure 3
   a. Nut
   b. Washer
   c. Step Washer
   d. Rubber Washer
   e. Nut or Flange Nut
   f. Washer (Early Models)
   g. Hose Clamps and Crankcase Ventilation Hoses
3. Remove Air Silencer assembly from carburetor as an assembly. Flip air silencer over and remove 4 screws which hold air silencer together. Remove Flame Arrestor.
4. Clean and Inspect:
   a. Clean Flame Arrestor by blowing it out with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, replace if necessary.
5. Reassemble Air Silencer assembly with 4 screws - Tighten securely.
6. Install (in following order):
   a. Air Silencer to Carburetor
   b. Crankcase Ventilation Hoses and Clamps
   c. Washer (Early Models)
   d. Nut or Flange Nut
   e. Rubber Washer
   f. Step Washer
   g. Washer
   h. Nut - Tighten Securely
7. Install air intake hose and clamp to air silencer and tighten clamp securely.



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a - Nut
b - Washer
c - Step Washer
d - Rubber Washer
e - Nut (Early Models)
f - Washer (Early Models)
g - Flange Nut (Later Models)
h - Flame Arrestor
i - Air Silencer
j - Screws

Figure 3. Flame Arrestor with Air Silencer

AIR INTAKE HOSE

⚠CAUTION

Improper installation of air intake hose may cause water or debris to be drawn into engine thru intake manifold. This could cause serious internal damage to engine, which will not be covered by MerCruiser Warranty.

Air intake hose (attached to carburetor air silencer on some models) must be positioned and secured so that inlet is a minimum of 12″ (305mm) above bottom of bilge (to prevent it from picking up water) and in an area where it will not pick up debris. DO NOT place inlet in storage bin, as small articles placed in bin may get sucked into inlet. DO NOT connect inlet to outside of boat, as water vapor/mist/splash may be drawn into inlet. Up to 3 ft. (914mm) of 5″ (127mm) ID hose can be added to end of air intake hose, if necessary to allow proper positioning of hose inlet.

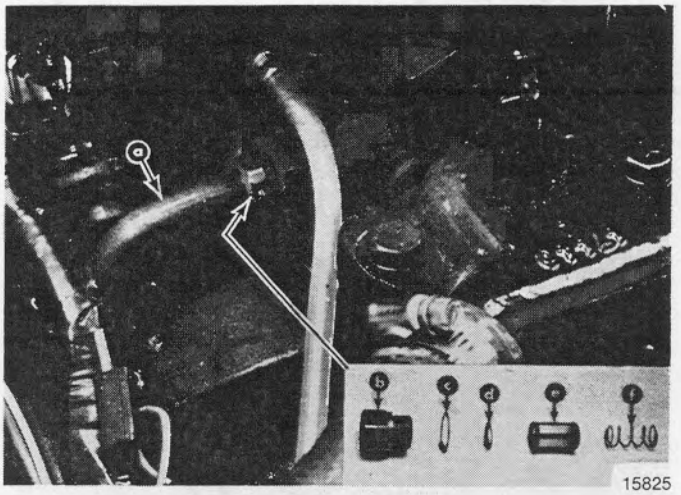
⚠CAUTION

To prevent air intake hose from moving out of position during operation, hose MUST BE fastened to boat with clamp.

FUEL FILTER

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove; Figure 1
   - Fuel line from fuel inlet filter nut
   - Fuel inlet filter nut
   - Large gasket
   - Filter
   - Spring
   - Small gasket - From inside filter nut



a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Large)
d - Gasket (Small)
e - Filter
f - Spring

Figure 1. Changing Fuel Filter

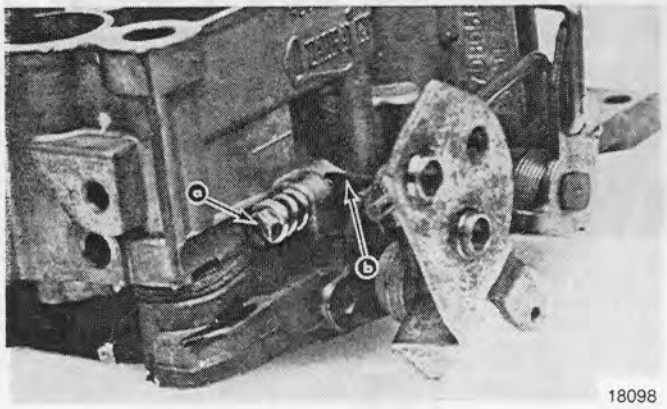
2. Clean filter nut and spring.
3. Install the following; Figure 1
   - Spring - Place in carburetor body
   - Filter - Open end to inlet filter nut
   - Small gasket - Place inside filter nut
   - Large gasket - Place over filter nut
   - Fuel inlet filter nut - Tighten to specifications
   - Fuel line - Tighten to specifications

ADJUSTMENTS

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

ACCELERATOR PUMP

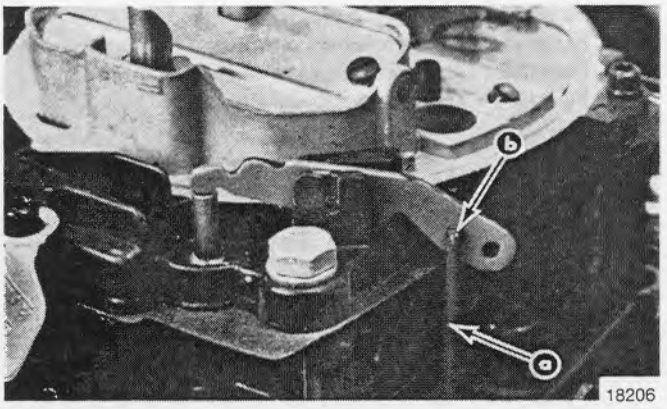
1. Back out idle stop screw until it no longer contacts throttle lever. (Figure 1)



a - Idle Stop Screw
b - Throttle Lever

Figure 1. Backing Out Idle Stop Screw

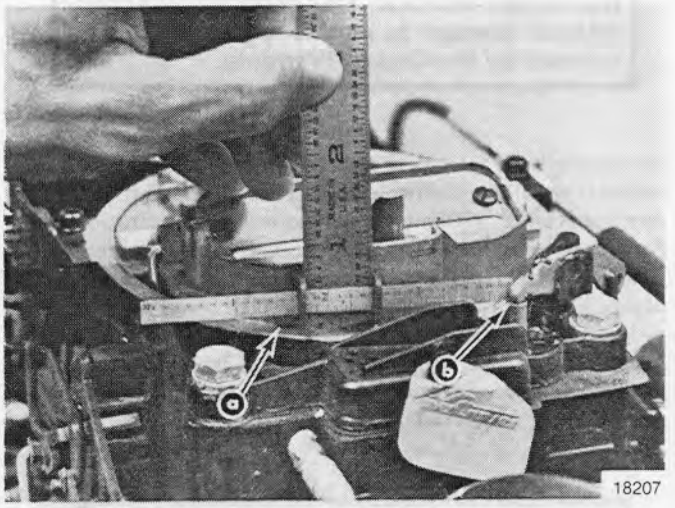
2. Pump rod must be in inner hole of lever. (Figure 2)



a - Pump Rod
b - Inner Hole

Figure 2. Pump Rod Location

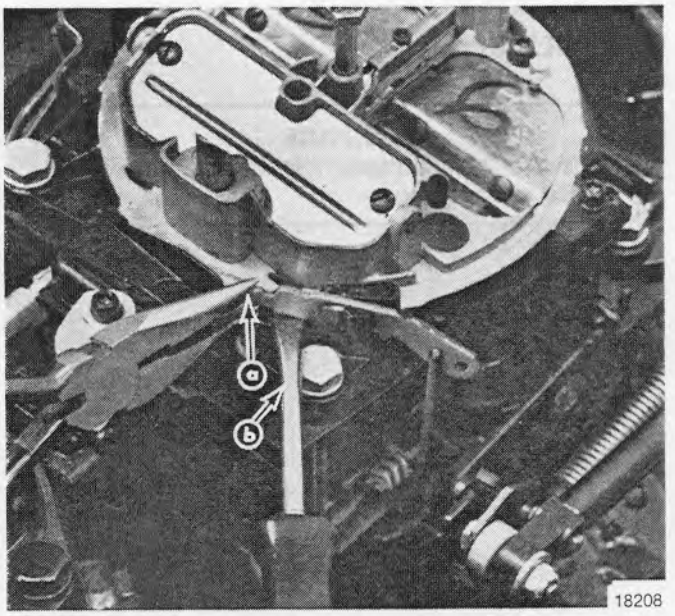
3. Close throttle valves completely and measure from flame arrestor mounting surface to top of pump plunger stem. (Figure 3)



a - Flame Arrestor Mounting Surface
b - Pump Plunger Stem

Figure 3. Measuring Pump Plunger Height

4. While supporting lever, bend tip of pump lever to obtain specified dimension. (Figure 4)

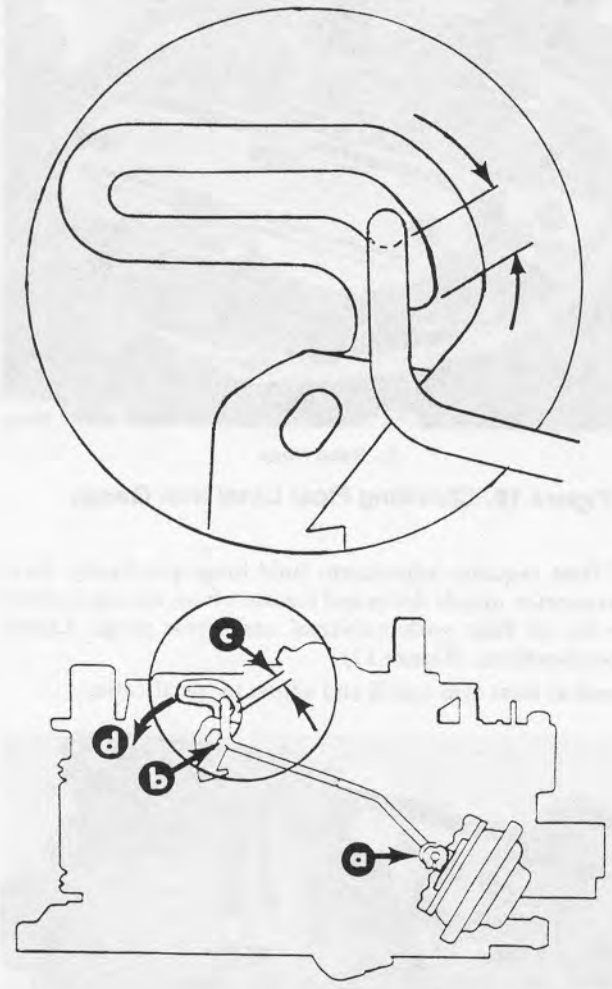


a - Tip of Pump Lever b - Support as Shown

Figure 4. Adjusting Pump Plunger Height

AIR VALVE DASHPOT

1. Seat vacuum break diaphragm and close air valve completely. Bend rod to adjust gap to specifications. (Figure 5)

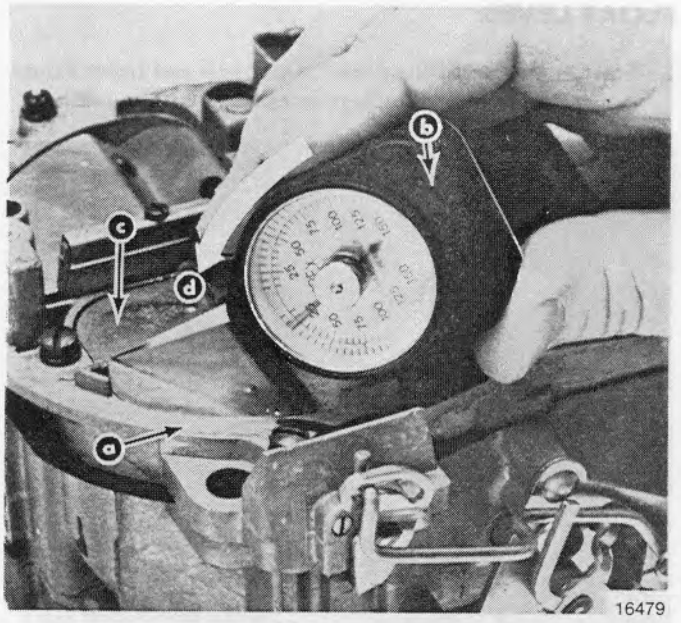


a - Push in Completely
b - Bend Here to Adjust
c - Specified Gap
d - Fully Closed

Figure 5. Adjusting Dashpot Link Rod.

AIR VALVE SPRING WINDUP

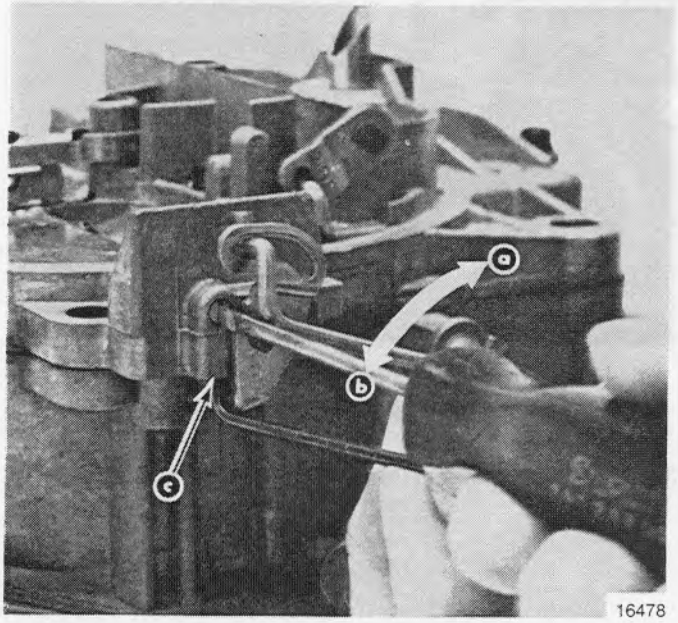
1. Rotate gram scale until air valve begins to open, check scale reading. (Figure 6)



a - Carburetor Casting
b - Gram scale
c - Contact Area of Arm on Air Valve
d - Rotate

Figure 6. Checking Air Valve

2. To adjust spring windup, hold tension spring screw and loosen allen head screw. (Figure 7)
3. Adjust tension and retighten allen screw securely. (Figure 7)

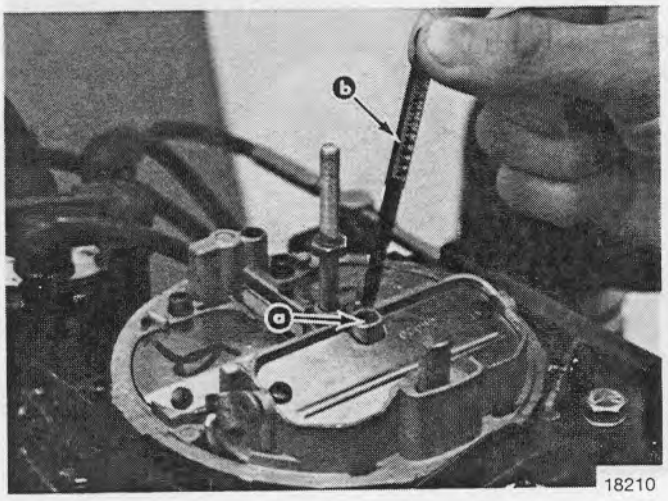


a - Increase
b - Decrease
c - Loosen Allen Head Screw

Figure 7. Adjusting Air Valve

FLOAT LEVEL

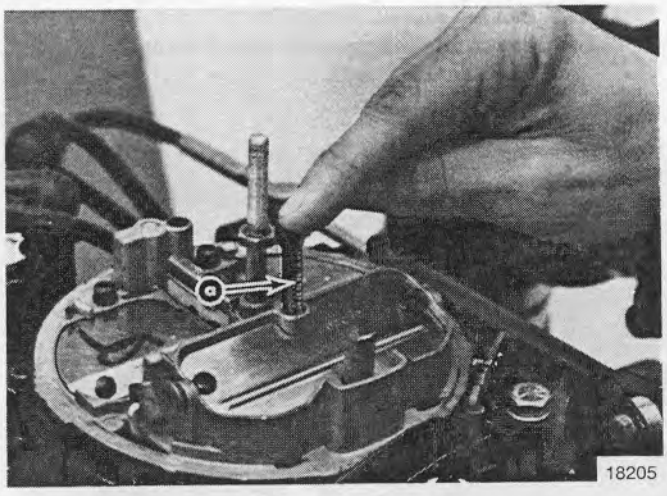
1. Start engine to fill float bowl, run at idle and insert float gauge into hole next to flame arrestor stud. (Figure 8)



a - Gauge Hole
b - Gauge (BT-8420A)

Figure 8. Installing Float Gauge

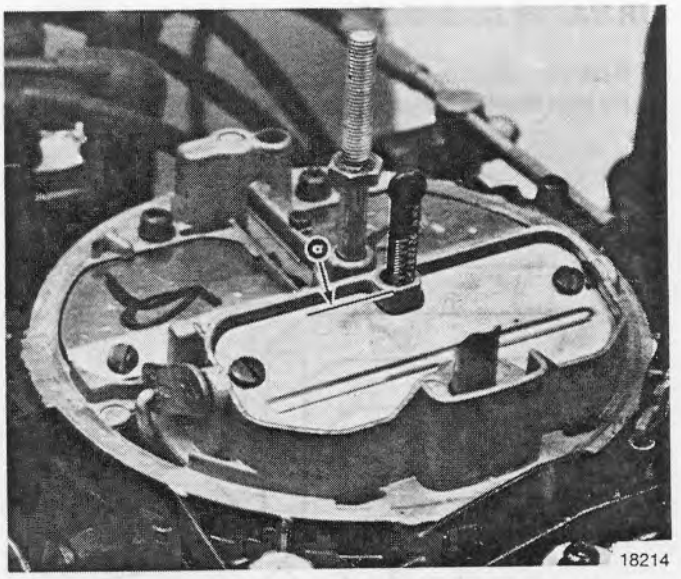
2. Tap float gauge down lightly to assure free movement. (Figure 9)



a - Gauge

Figure 9. Tapping Float Gauge

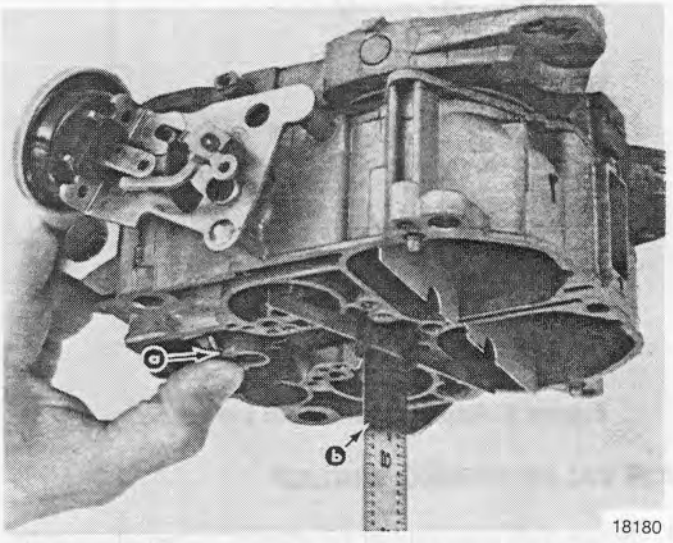
3. Take gauge reading at top of carburetor casting. (Figure 10)



a - Read Here

Figure 10. Checking Float Level with Gauge

4. If float requires adjustment hold hinge pin firmly, turn carburetor upside down and measure from casting surface to toe of float with universal carburetor gauge. Check specifications. (Figure 11)
5. Bend at float arm notch and adjust to specification.

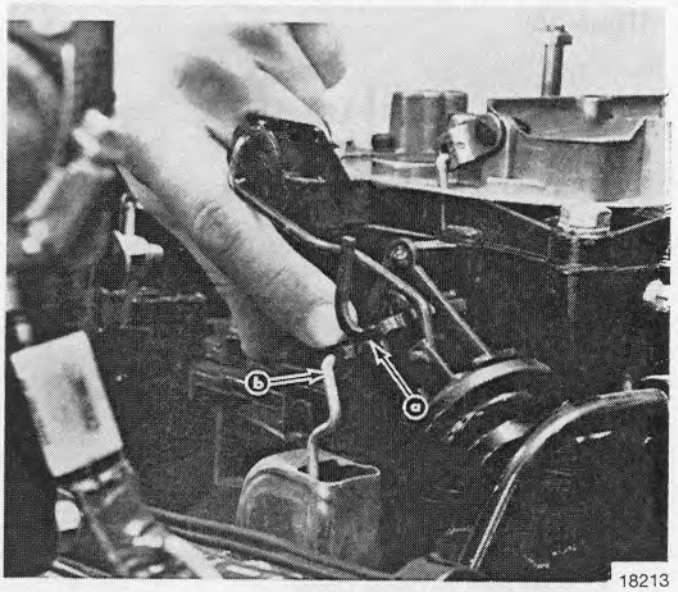


a - Hinge Pin b - Universal Carburetor Gauge

Figure 11. Adjusting Float

CHOKE COIL ROD

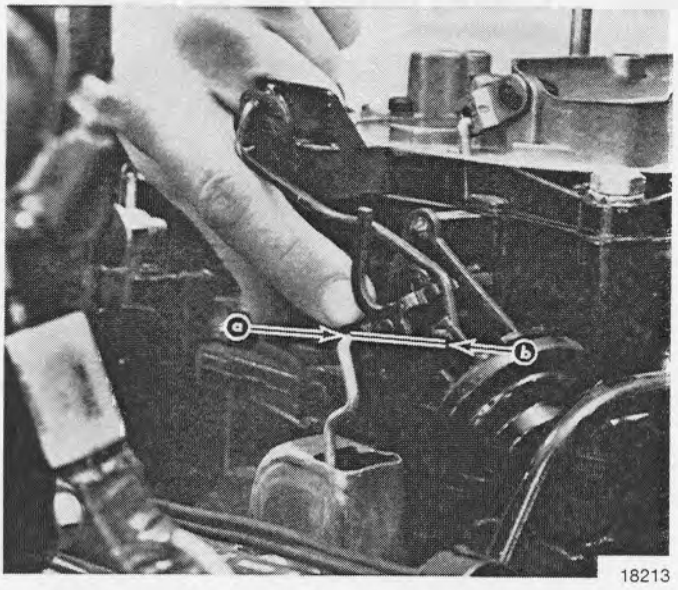
1. Push choke coil rod down. (Figure 12)



a - Vacuum Break Choke Lever
b - Choke Coil Rod

Figure 12. Pushing Choke Rod Down

2. Choke coil rod top must be even with bottom of hole in vacuum break choke lever. (Figure 13)



a - Top of Rod b - Bottom of Hole

Figure 13. Checking Choke Rod Adjustment

3. Bend rod to adjust. (Figure 14)

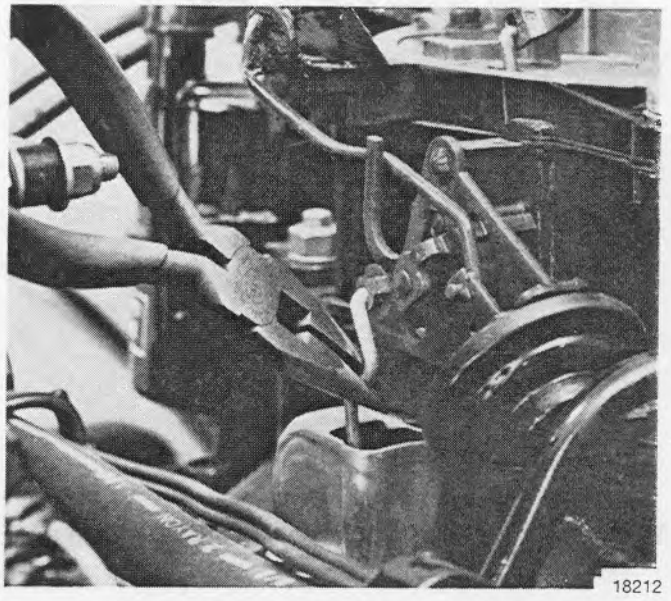
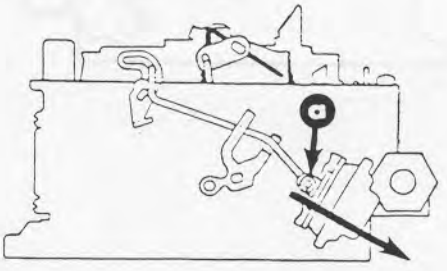


Figure 14. Bending Choke Coil Rod

VACUUM BREAK

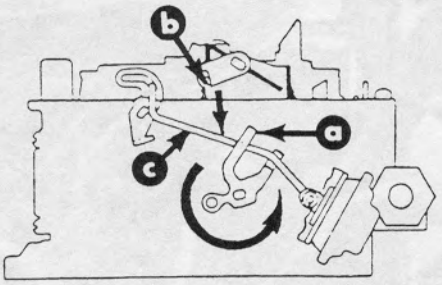
1. Seat vacuum break control diaphragm. (Figure 15)



a - Vacuum Break Control Diaphragm

Figure 15. Seating Vacuum Break Control Diaphragm

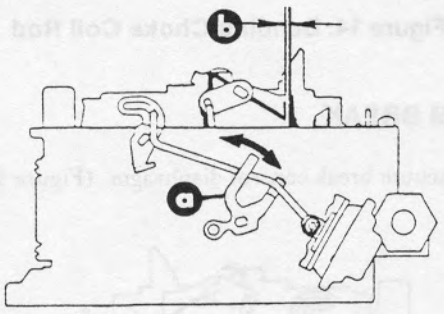
2. Rotate vacuum break choke lever counterclockwise until tang contacts vacuum break rod. Choke rod must be at bottom of choke shaft lever slot. (Figure 16)



a - Tang
b - Choke Rod
c - Vacuum Break Rod

Figure 16. Rotating Choke Lever

3. Bend tang as necessary to obtain specified choke valve gap. (Figure 17)

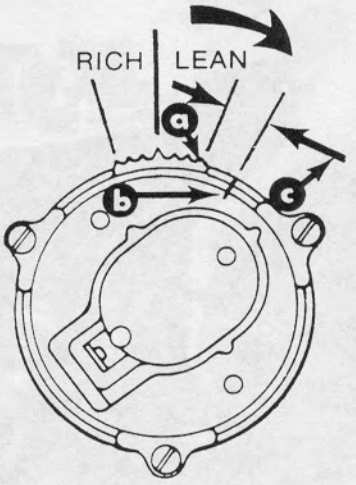


a - Tang b - Specified Gap

Figure 17. Checking Vacuum Break and Unloader Adjustment

ELECTRIC CHOKE ADJUSTMENT (4MC CARBURETORS)

1. Adjusting choke on 488R engines with 4MC carburetor. (Figure 18)



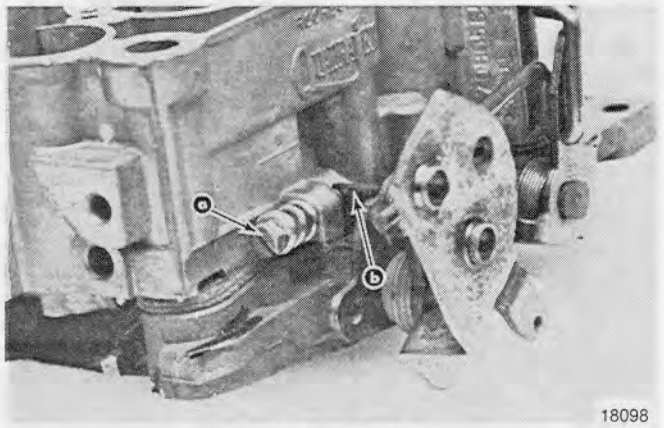
a - Last Index Mark on Choke Housing on Lean Side
b - Index Mark on Choke Cover
c - 1/4" (6mm)

Figure 18. Index Mark ¼" (6mm) Past the Last Lean Mark on Choke Housing

PRELIMINARY IDLE SPEED and MIXTURE

Initial start setting, make final adjustments with engine running.

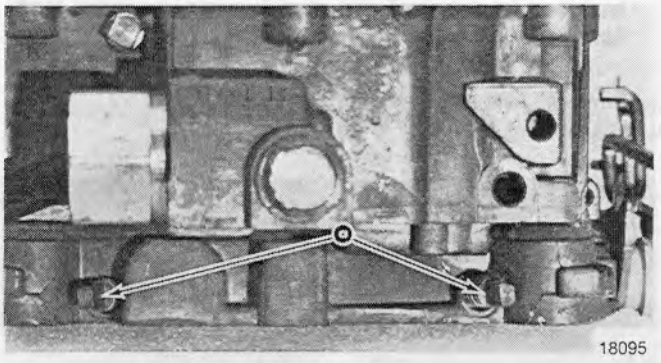
1. Turn idle stop screw until contact with throttle lever.



a - Idle Stop Screw
b - Throttle Lever

Figure 19. Idle Stop Screw and Throttle

2. Turn idle needles until LIGHTLY seated then back out 2 to 3 turns.



a - Idle Needles

Figure 20. Idle Mixture Needles

IMPORTANT: Do not turn idle mixture screws tightly against seat, as damage to seat and/or needle may result.

FINAL IDLE SPEED and MIXTURE

IMPORTANT: Boat MUST BE in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly, with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect a shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needles (Figure 20) tightly into seat, as damage to needle and/or seat may result.

2. If a new or rebuilt carburetor has been installed, turn each idle mixture needle (Figure 20) until it LIGHTLY contacts seat, then back out 2 to 3 turns. This will provide a sufficient setting to allow starting the engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

DO NOT leave the helm unoccupied while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable brass barrel from anchor stud. BE SURE NOT TO LOSE SPACER ON ANCHOR STUD.
6. Adjust idle speed adjustment screw (Figure 19) to obtain specified RPM.
7. With engine running at specified RPM, adjust idle mixture needles (Figure 20), as follows:
   a. Turn idle mixture needle inward (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw outward (counterclockwise) until the speed begins to drop due to a rich mixture.
   c. Turn screw inward to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Repeat procedure with other needle.
   e. Readjust idle speed adjusting screw, if necessary, to obtain specified RPM.

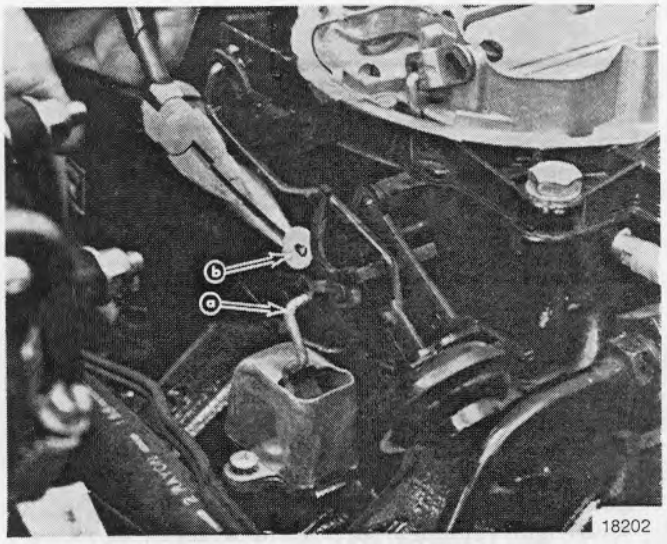
IMPORTANT: Refer to "Section 2" for throttle cable installation and adjustment.

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

REMOVAL

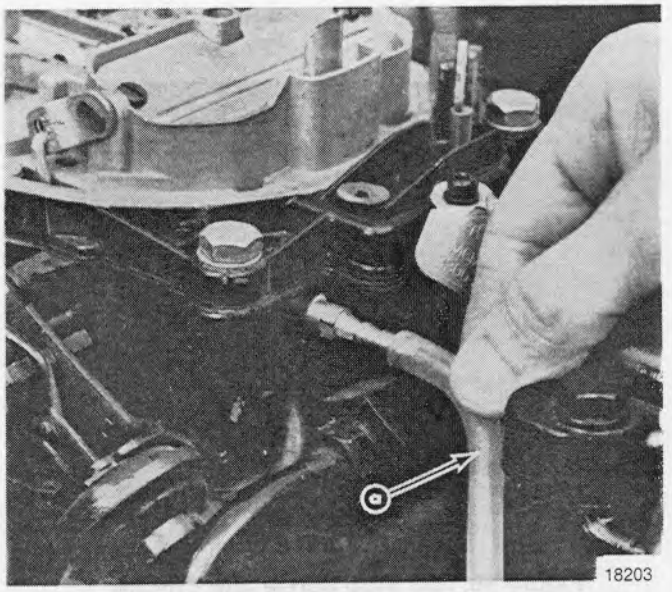
1. Remove flame arrestor.
2. Disconnect choke spring rod if working on 4MV carburetor. (Figure 1)



a - Choke Rod
b - Clip

Figure 1. Removing Choke Spring Rod (4MV Carburetor)

3. Disconnect sight tube (if equipped). (Figure 2)

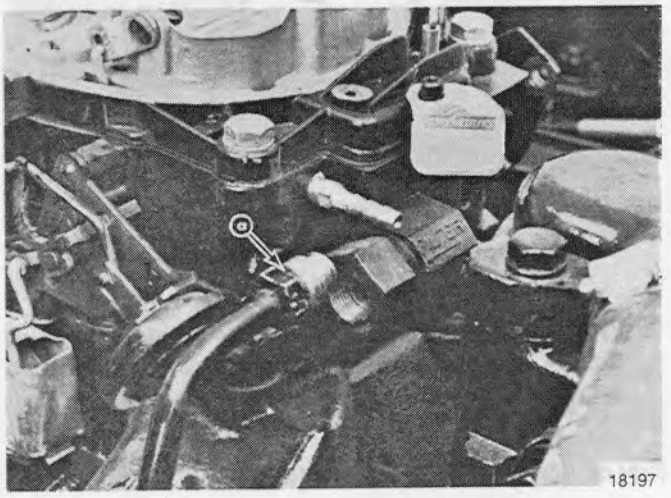


a - Sight Tube

Figure 2. Removing Sight Tube

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

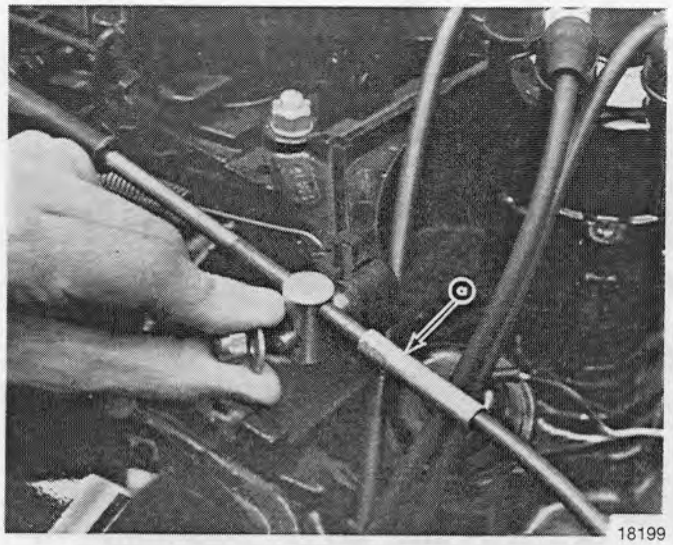
4. Turn off fuel supply at the fuel tank.
5. Disconnect fuel line. (Figure 3)



a - Fuel Line

Figure 3. Removing Fuel Line

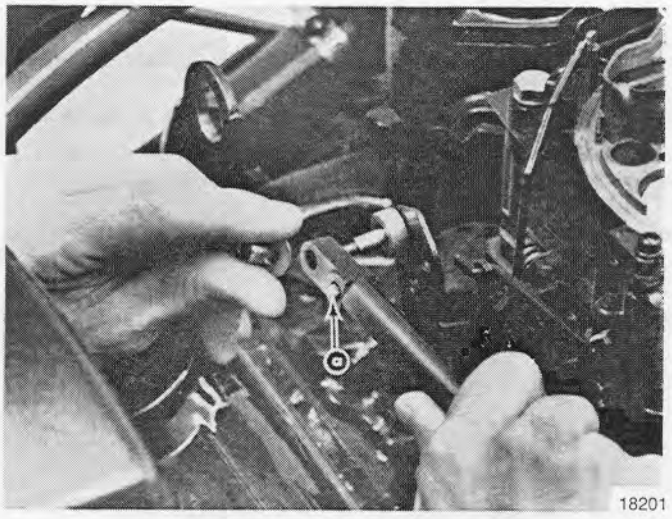
6. Disconnect throttle cable. (Figure 4)



a - Throttle Cable

Figure 4. Removing Throttle Cable

7. Disconnect cable end guide. (Figure 5)



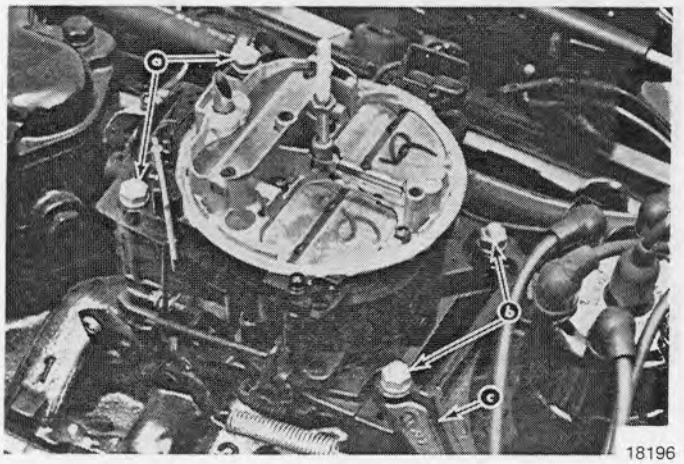
a- Cable End Guide

Figure 5. Removing Cable End Guide

8. Remove electric choke wires if working on a 4MC model carburetor.
9. Remove retaining nuts and bolts, remove carburetor and cable bracket. (Figure 6)

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

10. Remove old gasket from carburetor and manifold.

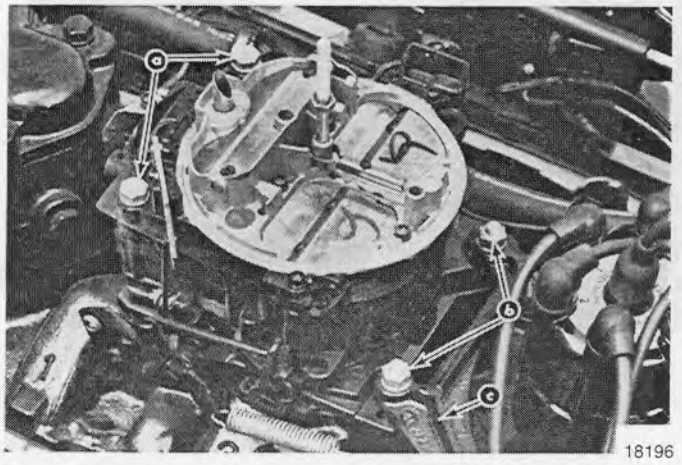


a - Bolts
b - Nuts
c - Cable Bracket

Figure 6. Removing Carburetor

INSTALLATION

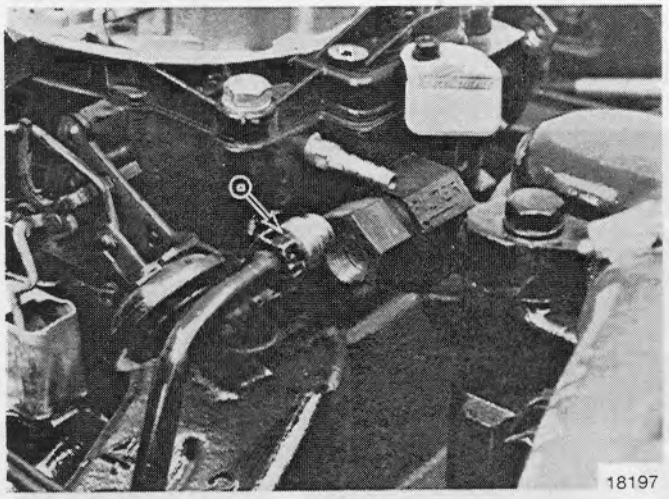
1. Install new gasket onto manifold.
2. Install carburetor and throttle bracket and torque to specifications. (Figure 7)



a - Mounting Bolts b - Nuts c - Throttle Bracket

Figure 7. Installing Carburetor

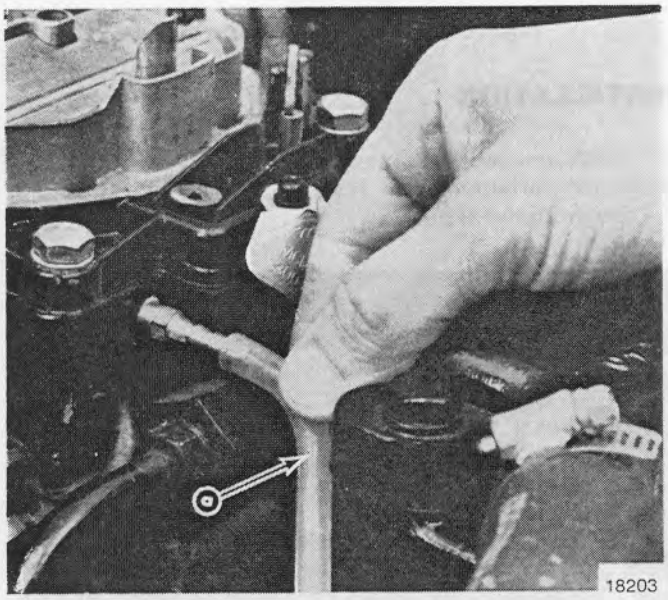
3. Connect fuel line and torque to specifications. (Figure 8)



a - Fuel Line

Figure 8. Connecting Fuel Line

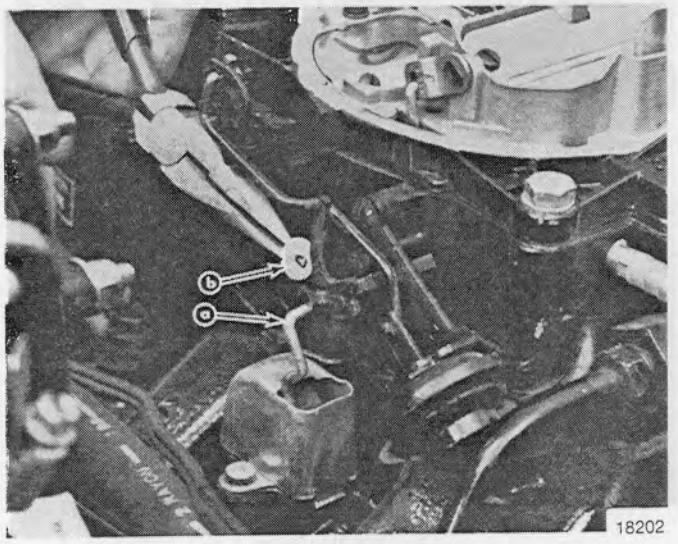
4. Connect fuel sight tube. (Figure 9)



a - Sight Tube

Figure 9. Connecting Sight Tube

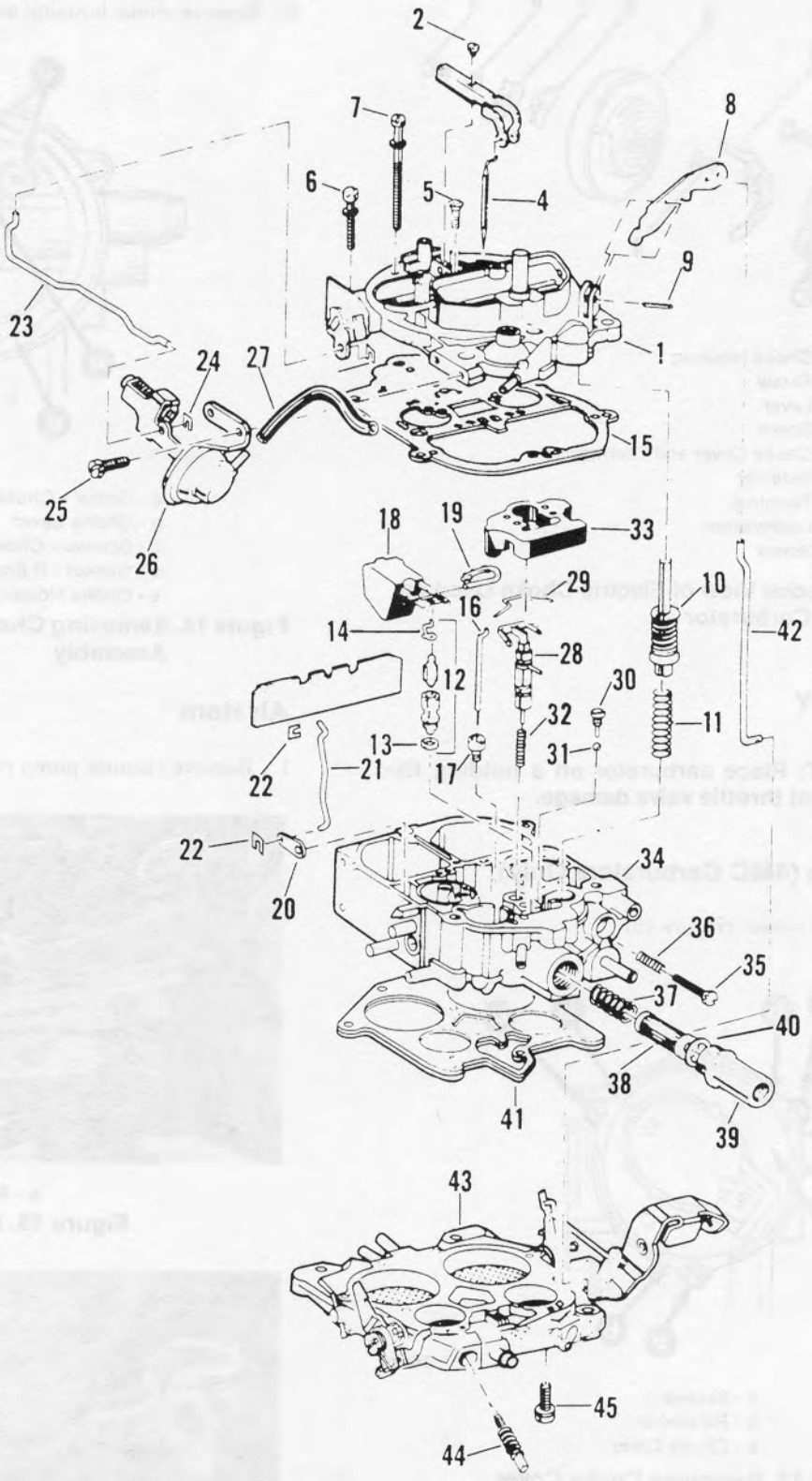
5. Connect choke link and install retaining clip, if working on 4MV carburetor. (Figure 10)



a - Choke Link
b - Clip

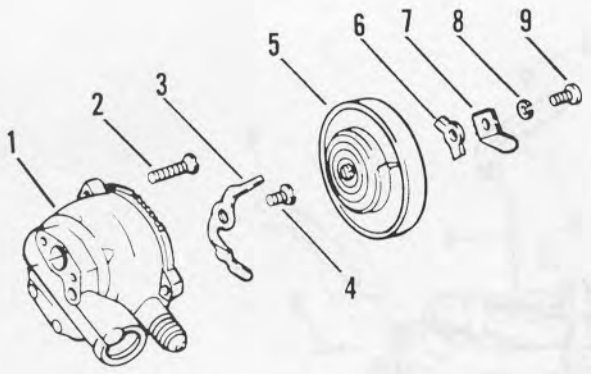
Figure 10. Connecting Choke Spring Rod (4MV Carburetor)

6. Connect electric choke wires if working on 4MC carburetor.
7. To install throttle cable refer to "Section 2, Removal, Installation, and Alignment".
8. Install flame arrestor and tighten securely.
9. Reconnect battery cables to battery.
10. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
11. Adjust idle speed and idle mixture, as outlined under "Adjustments" preceding.



1 - Air Horn Assembly
2 - Screw
3 - Hanger
4 - Metering Rod, secondary
5 - Screw
6 - Screw
7 - Screw
8 - Lever
9 - Roll Pin
10 - Pump
11 - Spring
12 - Needle and Seat
13 - Gasket
14 - Pull Clip
15 - Gasket
16 - Metering Rod, primary
17 - Jet, primary
18 - Float Assembly
19 - Pin, hinge - float
20 - Lever, intermediate choke
21 - Rod
22 - Clip
23 - Rod
24 - Clip
25 - Screw
26 - Control
27 - Hose
28 - Power Piston
29 - Retainer, power piston
30 - Retainer, pump discharge ball
31 - Ball, pump discharge
32 - Spring, power piston
33 - Insert, float bowl
34 - Float Bowl
35 - Screw, idle stop
36 - Spring, idle stop screw
37 - Spring, filter nut
38 - Filter, fuel inlet
39 - Nut, fuel inlet
40 - Gasket
41 - Gasket
42 - Rod
43 - Throttle Body
44 - Idle Needle
45 - Screw

Figure 11. Exploded View - 4MV/4MC Quardrajet (Rochester Carburetor)



1 - Choke Housing
2 - Screw
3 - Lever
4 - Screw
5 - Choke Cover and Thermostat
6 - Retainer
7 - Terminal
8 - Lockwasher
9 - Screw

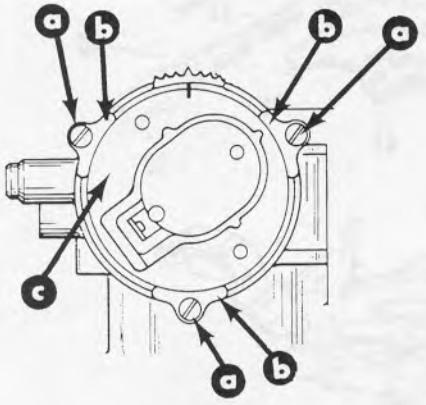
Figure 12. Exploded View of Electric Choke Used on 4MC Carburetor

DISASSEMBLY

IMPORTANT: Place carburetor on a holding fixture to prevent throttle valve damage.

Electric Choke (4MC Carburetors Only)

1. Remove choke cover. (Figure 13)

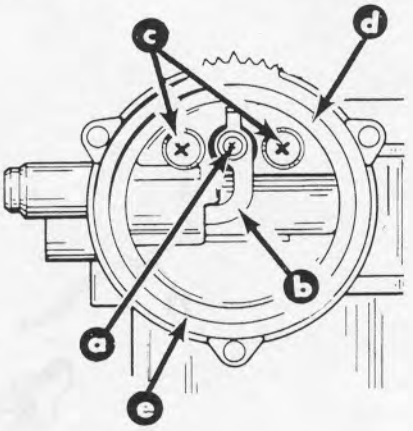


384-H

a - Screws
b - Retainers
c - Choke Cover

Figure 13. Removing Choke Cover

2. Remove choke lever screw. (Figure 14)
3. Remove choke housing assembly. (Figure 14)



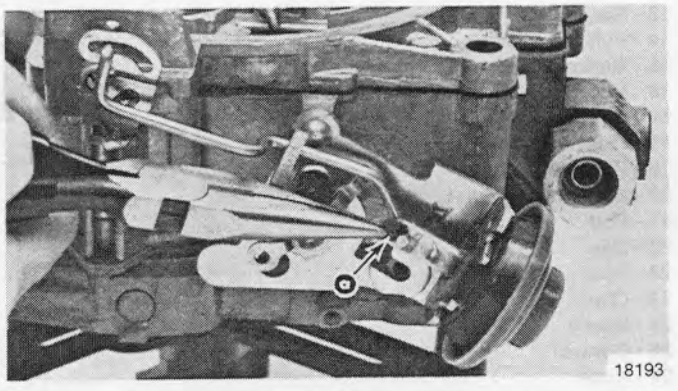
384-H

a - Screw - Choke Lever
b - Choke Lever
c - Screws - Choke Housing Assembly
d - Gasket - If Equipped (Not Visible)
e - Choke Housing Assembly

Figure 14. Removing Choke Lever and Choke Housing Assembly

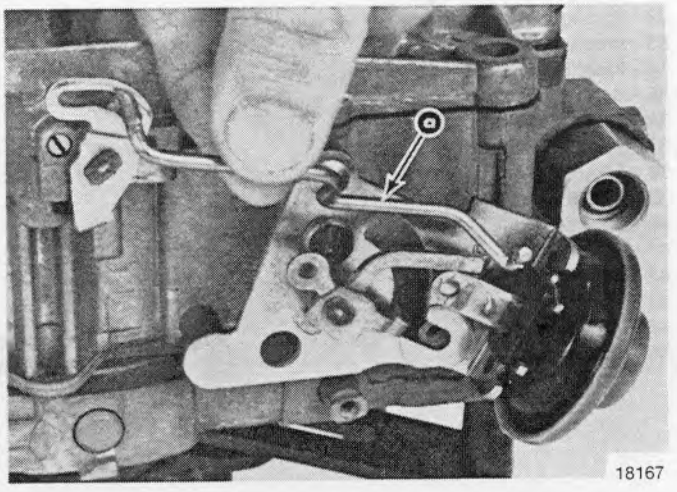
Air Horn

1. Remove vacuum pump rod clip and rod. (Figure 15)



a - Rod Clip

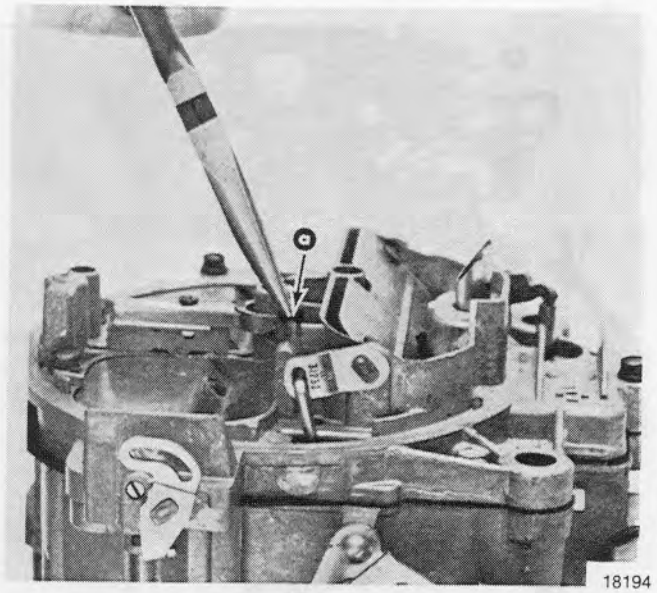
Figure 15. Removing Clip



a - Rod

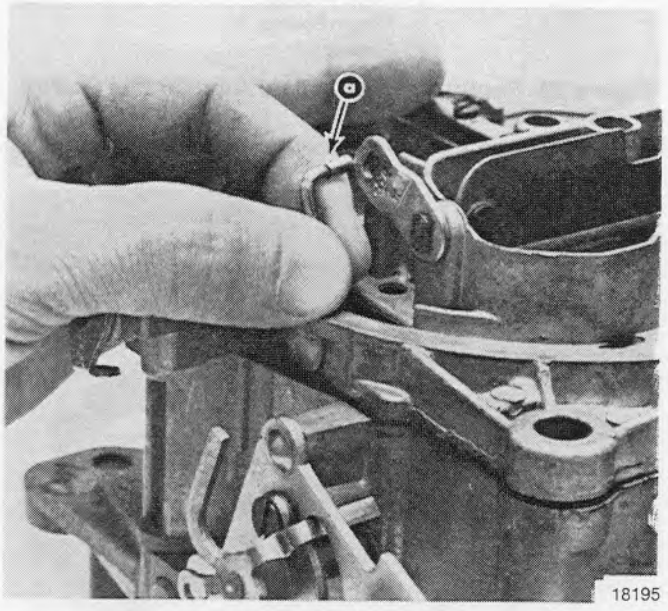
Figure 16. Removing Vacuum Pump Rod

2. Remove choke shutter clip and rod. (Figures 17 and 18)



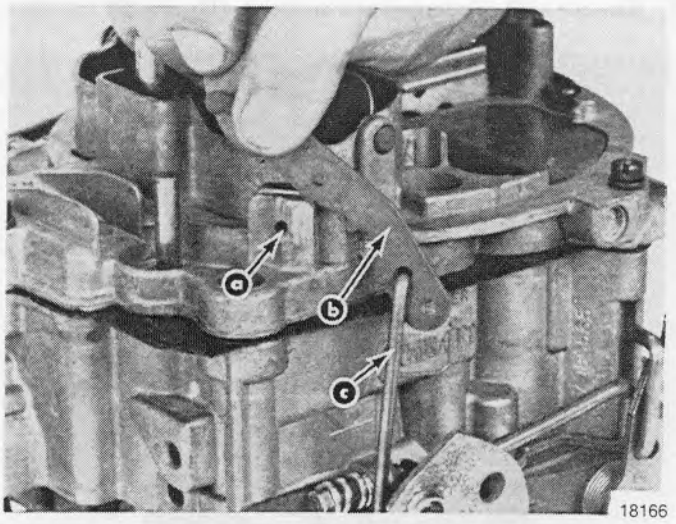
a - Clip

Figure 17. Removing Choke Rod Clip



a - Rod

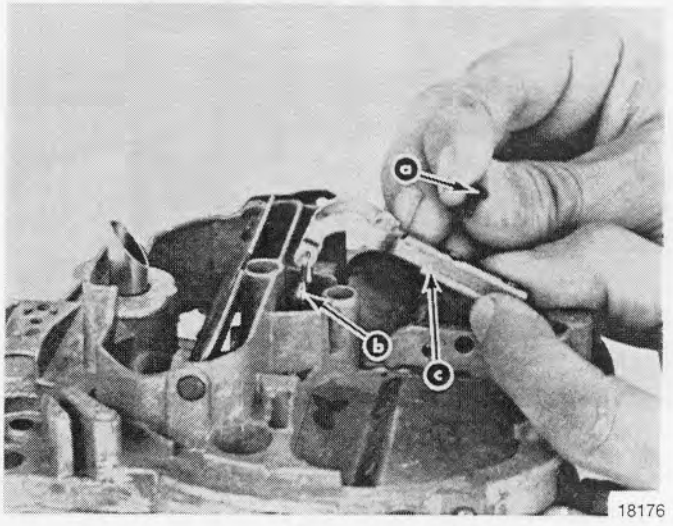
Figure 18. Removing Choke Rod



a - Roll Pin (Not Shown)
b - Pump Lever
c - Rod

Figure 19. Removing Accelerator Pump Lever

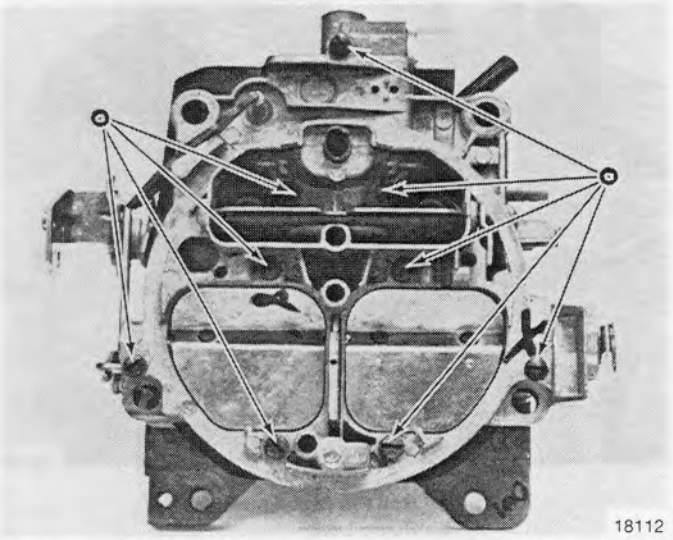
3. Drive roll pin back and remove accelerator pump lever and rod. (Figure 19)
4. Remove screw, secondary metering rods and hanger. (Figure 20)



a - Screw b - Metering Rods c - Hanger

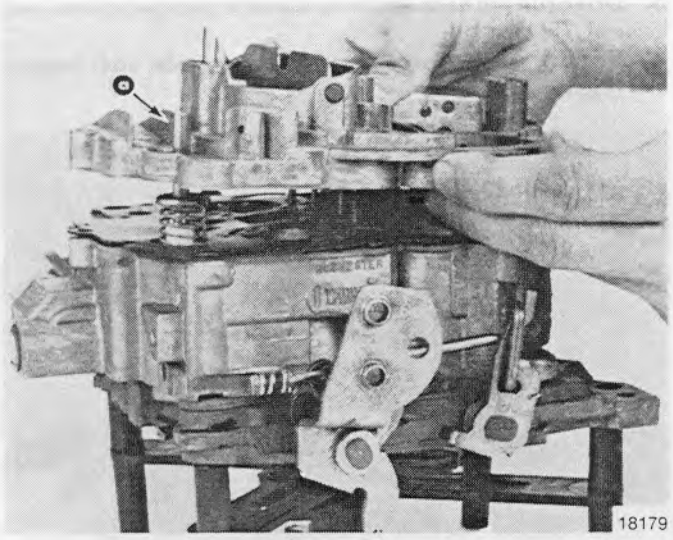
Figure 20. Removing Metering Rods and Hanger

5. Remove air horn screws and air horn. (Figures 21 and 22)



a - Air Horn Screws

Figure 21. Air Horn Screws



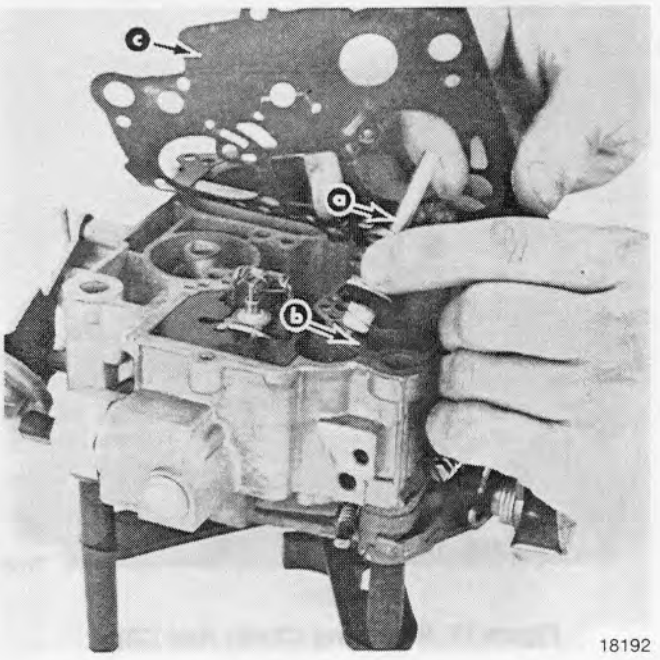
a - Air Horn

Figure 22. Removing Air Horn

Float Bowl

NOTICE
Refer to "Important Service Information", when repairing a 4MC carburetor (Rochester NO. 17083522), BEFORE proceeding.

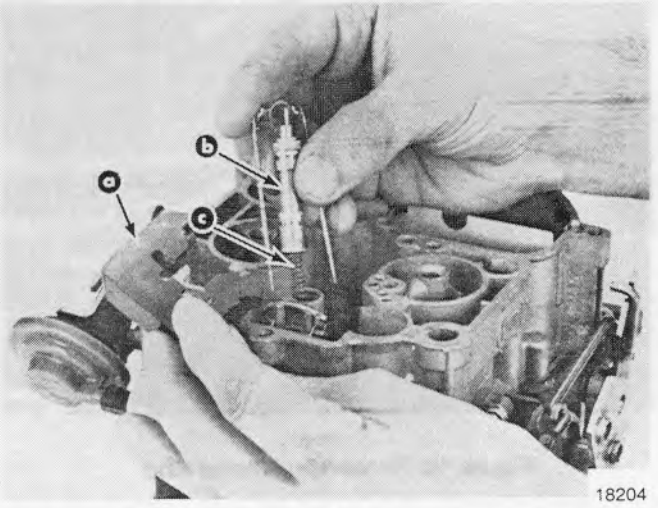
1. Remove pump plunger, return spring and gasket. (Figure 23)



a - Pump Plunger
b - Return Spring
c - Gasket

Figure 23. Removing Gasket and Accelerator Pump

2. Remove insert block, power piston and spring. (Figure 24)



a - Insert Block b - Power Piston c - Spring

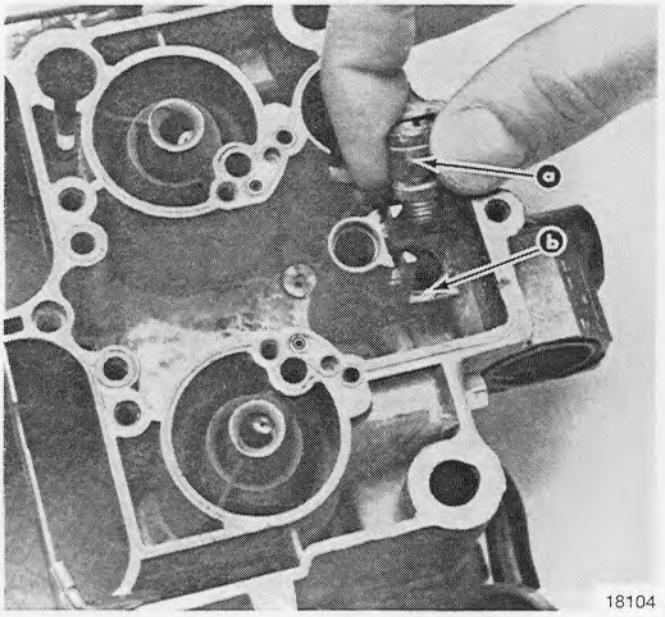
Figure 24. Removing Insert Block and Power Piston

3. Remove float assembly, needle, and retaining pin. (Figure 25)

a - Float Assembly
b - Needle
c - Retaining Pin

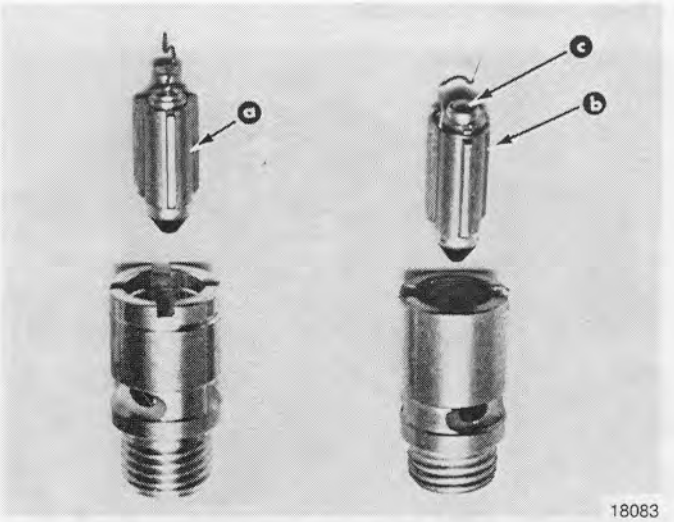
Figure 25. Removing Float and Inlet Needle

4. Remove fuel inlet seat and gasket. (Figure 26)



a - Fuel Inlet Seat
b - Gasket

Figure 26. Removing Inlet Seat

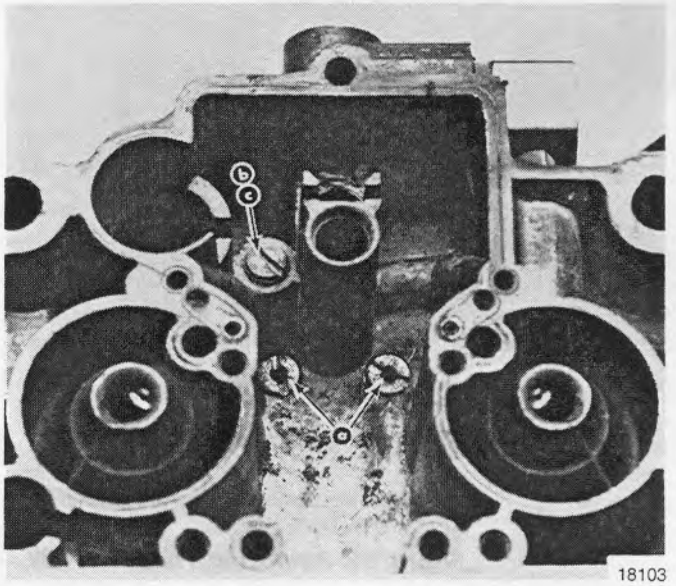


a - Solid Needle (1397-8548)
b - Spring Loaded Needle (1397-8960)
c - Spring Loaded Ball

Figure 27. Types of Needles used in 488R Carburetor

IMPORTANT: 4MV carburetors will have a solid needle. (Figure 27) 4MC carburetors may have a spring loaded or solid needle. (Figure 27) It is important to install the same type of needle that was removed from the 4MC carburetors.

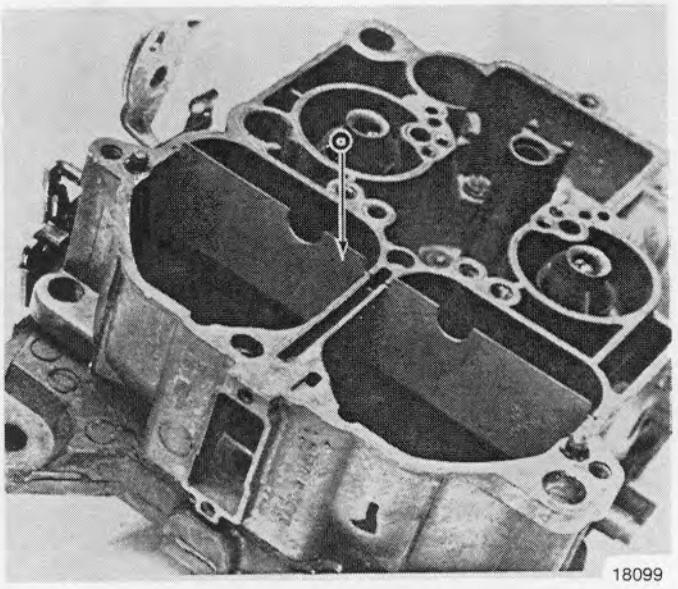
5. Remove primary metering jets, pump discharge check ball retainer and check ball. (Figure 28)



a - Primary Metering Jets
b - Pump Discharge Retainer
c - Check Ball (Not Visible)

Figure 28. Removing Primary Jets and Retainer and Check Ball

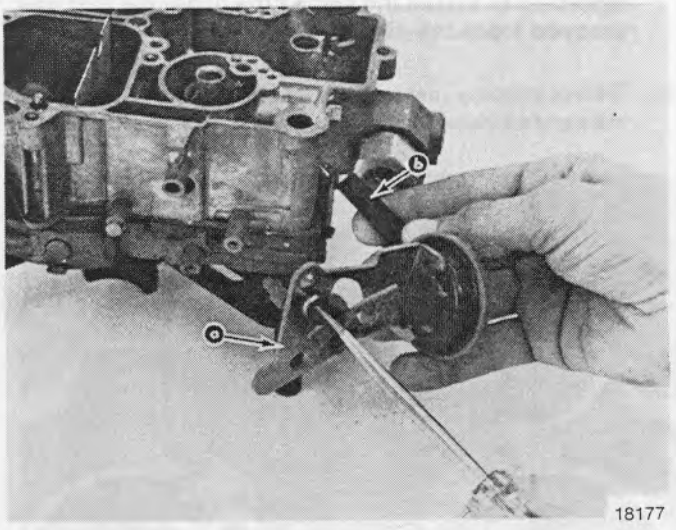
6. Remove baffle. (Figure 29)



a - Baffle

Figure 29. Removing Baffle

7. Remove vacuum control assembly and hose. (Figure 30)



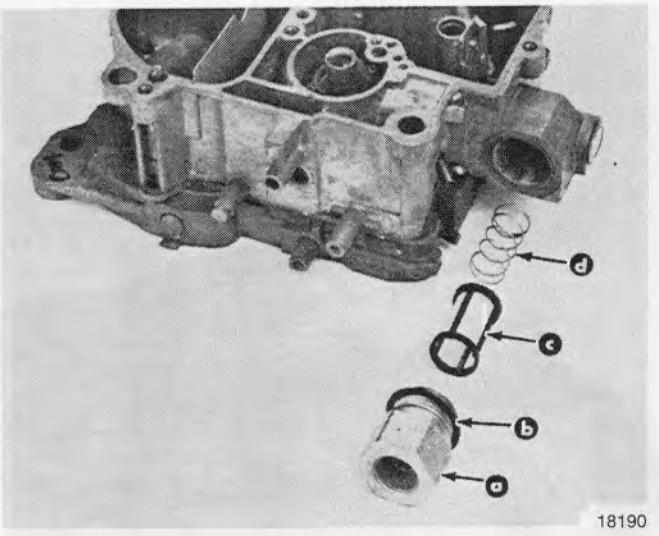
a - Vacuum Control Assembly
b - Hose

Figure 30. Removing Vacuum Control

a - Attaching Screws
b - Throttle Body
c - Gasket
d - Float Bowl

Figure 32. Removing Throttle Body

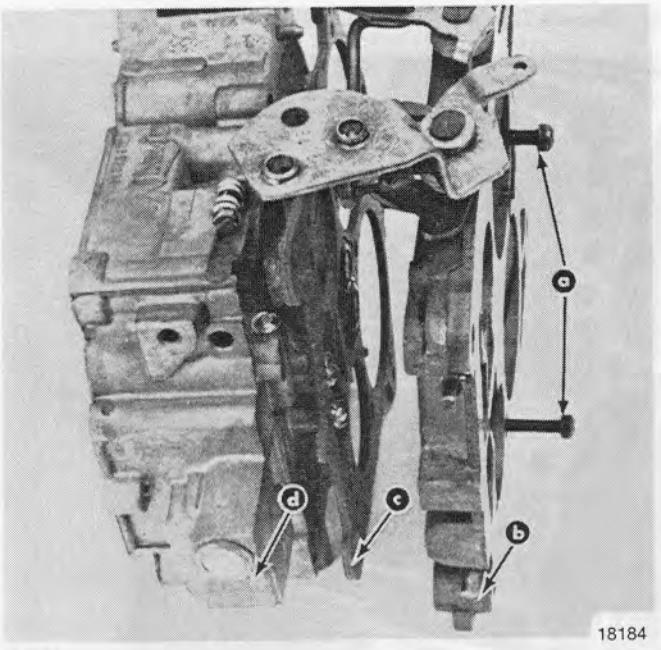
8. Remove fuel inlet filter nut, gaskets, filter and spring. (Figure 31)



a - Nut
b - Gaskets
c - Filter
d - Spring

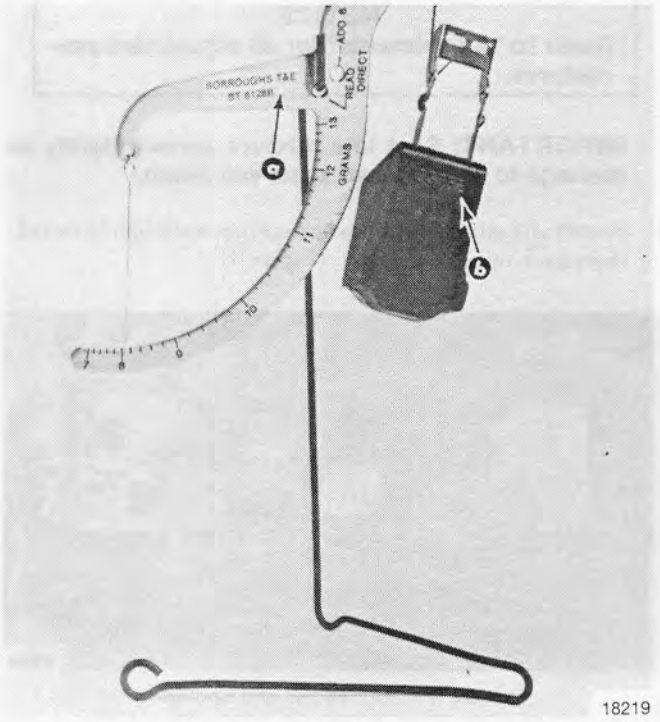
Figure 31. Removing Fuel Inlet Filter Assembly

9. Separate throttle body from float bowl and remove gasket. (Figure 32)



Float Weight

1. Assemble float scale to instructions with scale.
2. Check float wight to specifications. (Figure 33)



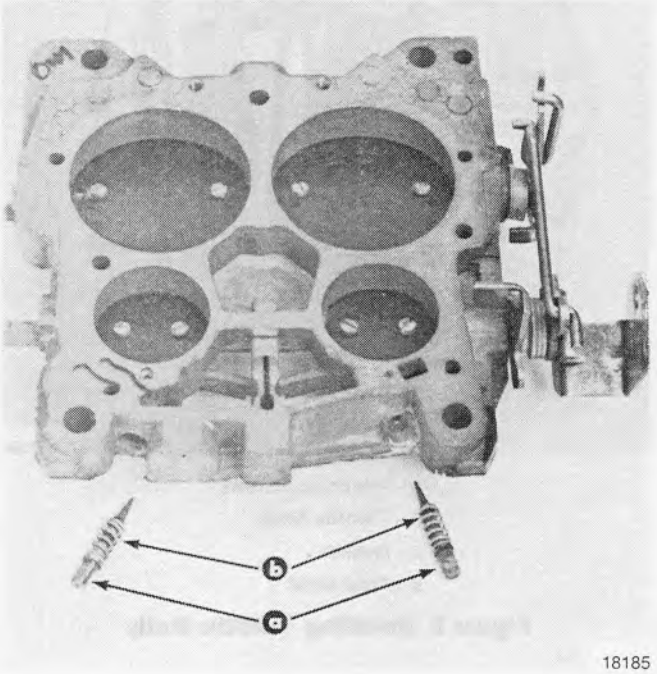
a - Float Scale
b - Float

Figure 33. Checking Float Weight

3. Replace float if it exceeds specifications.

Throttle Body

1. Remove idle mixture screws and springs. (Figure 34)



a - Screw
b - Spring

Figure 34. Removing Idle Mixture Screws

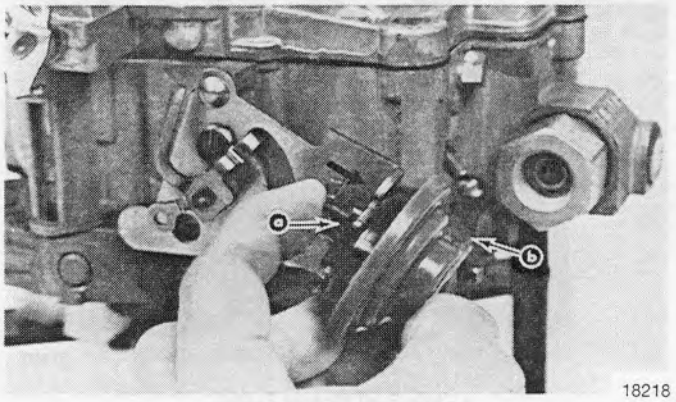
IMPORTANT: Throttle body should not be disassembled any further than shown. Throttle body is serviced as an assembly only.

CLEANING and INSPECTION

⚠CAUTION

Rubber, or plastic parts, pump plungers or diaphragms cannot be immersed in carburetor cleaner. The delrin air valve cam will withstand normal carburetor cleaner.

1. Clean carburetor in immersion type cleaner.
2. Blow out passages with compressed air. Do not run drill thru passages.
3. Inspect for wear:
   - Idle mixture needles
   - Float needle and seat
   - Casting surfaces
   - All levers
   - Fast idle cam
   - Power piston
   - Accelerator pump seal
4. Check all valves for binding.
5. Check vacuum break unit for leaks.
   a. Depress plunger and seal hose connection. (Figures 1 and 2).



a - Plunger
b - Hose Connection

Figure 1. Seating Plunger

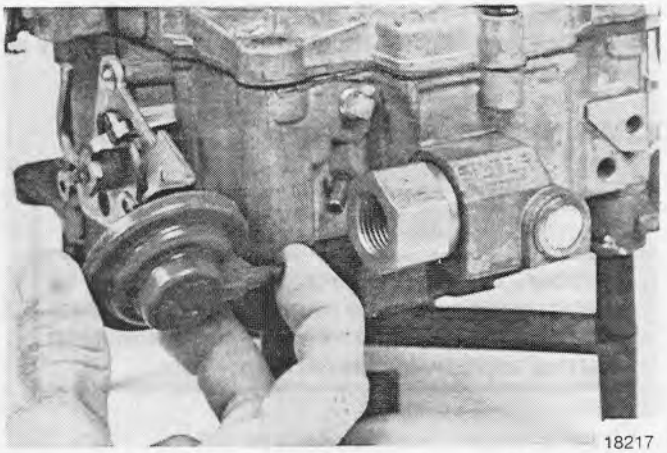
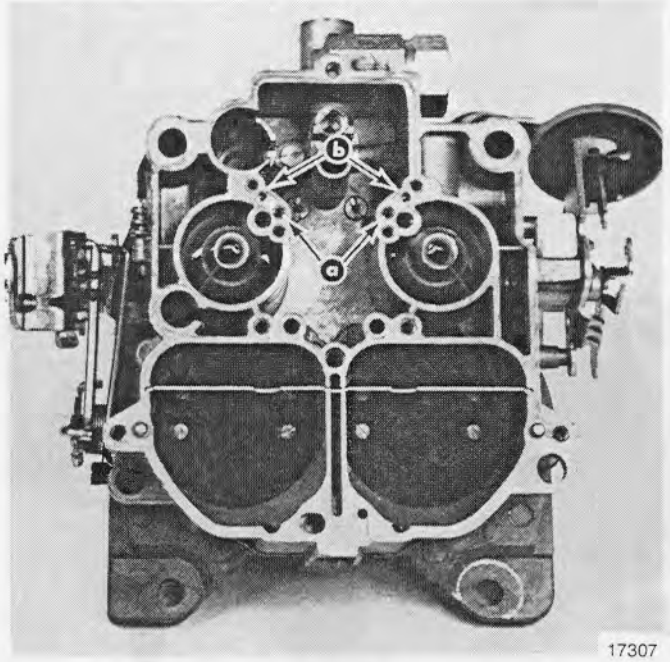


Figure 2. Plunger Seated and Hose Connection Sealed

b. Maintain seal on hose connection, plunger must remain seated. If plunger extends, replace unit. (Figure 2)

IMPORTANT: The idle fuel pickup tubes have a smaller I.D. at the bottom than the top. Do not drill.

6. Clean idle fuel pickup tubes with a fine wire (approx. .020" O.D.) and blow out all channels with compressed air. (Figure 3)



a - Idle Fuel Pickup Tubes
b - Channel Restrictions

Figure 3. Cleaning Idle Passages

IMPORTANT: If engine is experiencing a rough idle situation and cannot be smoothed out with idle adjustment screws, drill out the channel restrictions to .055", using a No. 54 drill. (Figure 3) Blow out channel with compressed air to clean out. Some later model carburetors already have this operation completed.

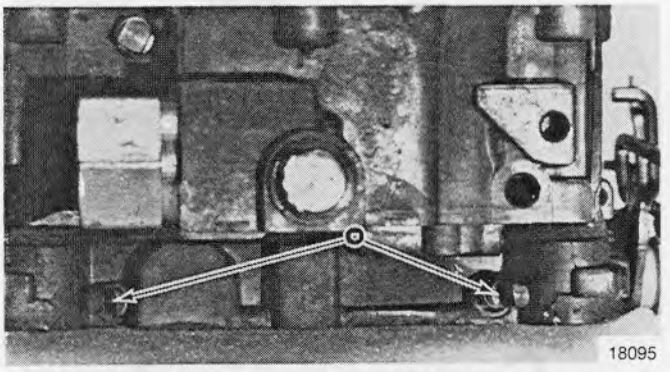
REASSEMBLY

Throttle Body

NOTICE
Refer to "Adjustments" for all adjustment procedures.

IMPORTANT: Seat idle mixture screws lightly or damage to needles and seats will result.

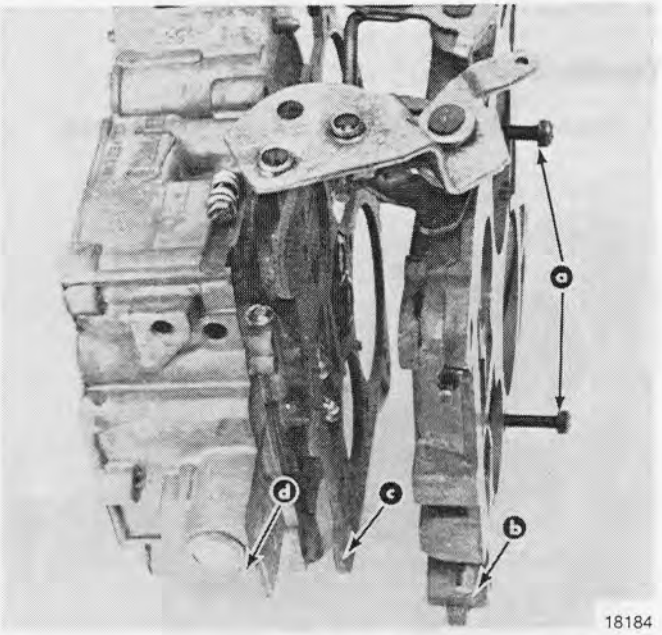
1. Install idle mixture needles and springs until lightly seated, then back out 2 or 3 turns. (Figure 1)



a - Idle Mixture Needles and Springs

Figure 1. Installing Idle Mixture Needles

2. Install new gasket and assemble throttle body to float bowl. Tighten securely. (Figure 2)



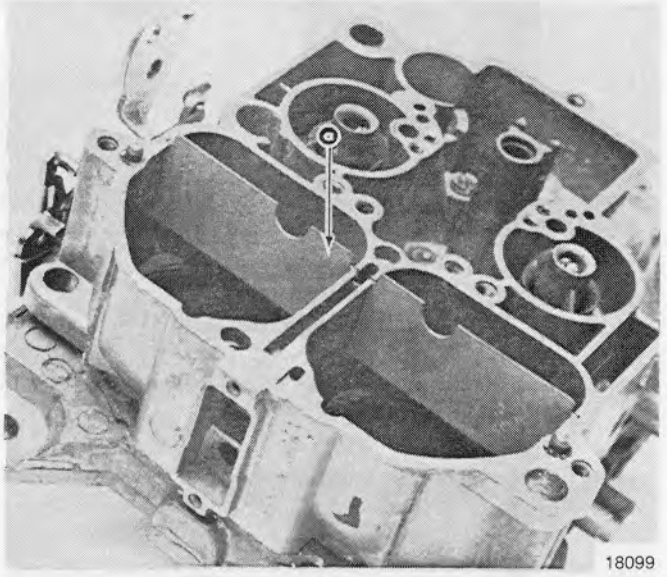
a - Attaching Screws
b - Throttle Body
c - Gasket
d - Float Bowl

Figure 2. Installing Throttle Body

NOTICE
Refer to "Important Service Information", BEFORE proceeding.

IMPORTANT: Place carburetor on a holding fixture to prevent damage to throttle valve.

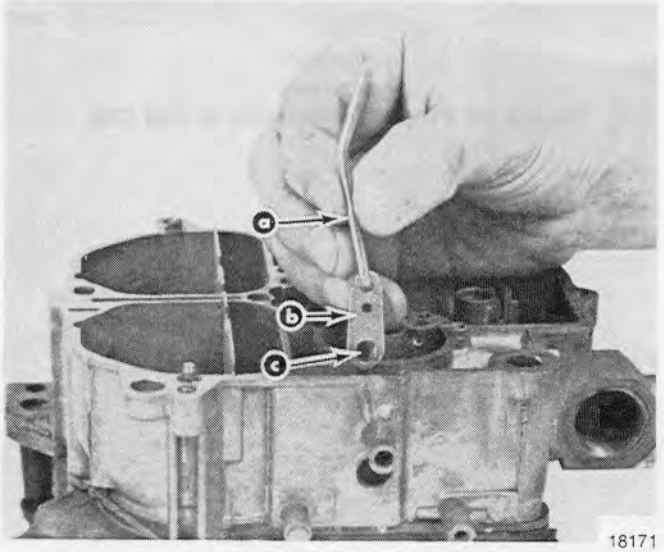
1. Install baffle plate. (Figure 3)



a - Baffle Plate

Figure 3. Installing Baffle Plate

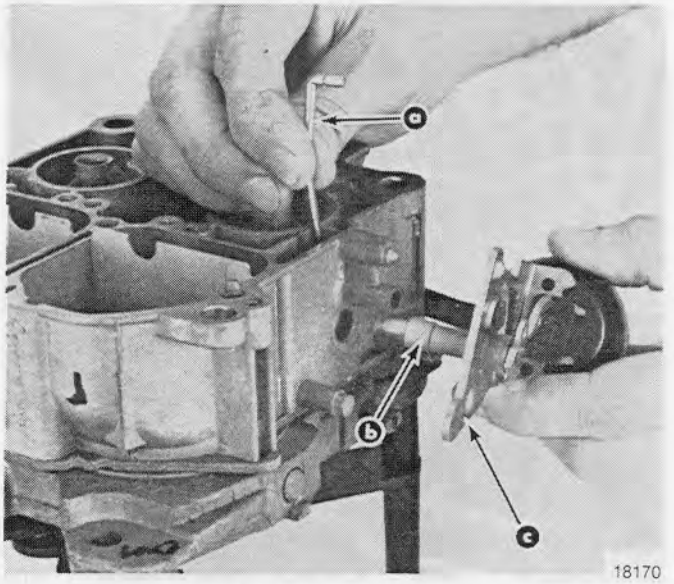
2. Install intermediate choke lever and vacuum break control bracket assembly. (Figure 4)
   a. Using choke rod, suspend intermediate choke lever in float bowl cavity so that flat sided hole aligns with hole in side of float bowl.



a - Choke Rod b - Choke Lever c - Flat Sided Hole

Figure 4. Installing Choke Rod and Lever

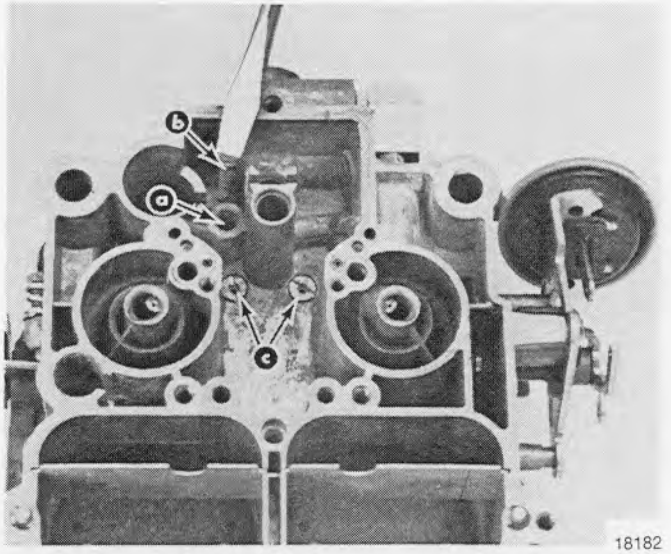
   b. Insert choke shaft on vacuum break control assembly to engage flat sided hole of choke lever, and secure with screw. Tighten securely. (Figure 5)



a - Choke Rod
b - Choke Shaft
c - Vacuum Break Control Assembly

Figure 5. Installing Choke Rod to Vacuum Break

3. Install pump discharge check ball, retainer and primary main metering jets. Tighten securely. (Figure 6)

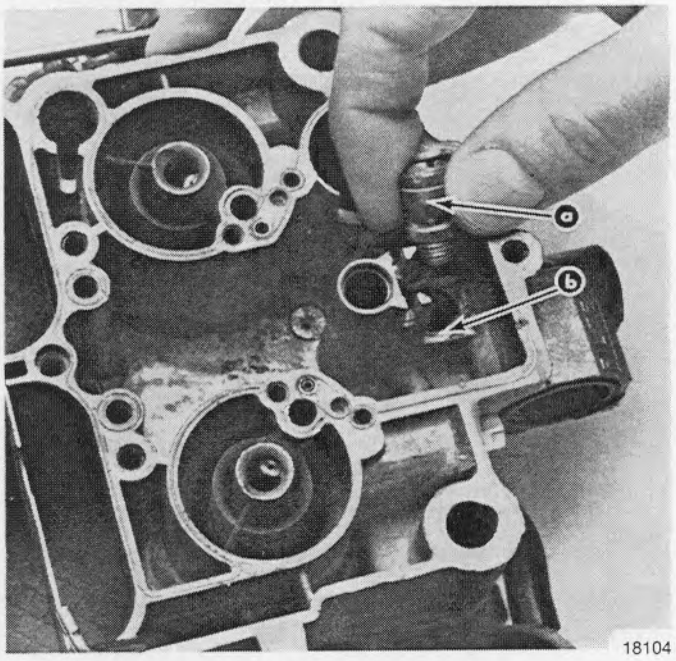


a - Check Ball (Not Shown)
b - Retainer
c - Primary Main Metering Jets

Figure 6. Installing Check Ball, Retainer and Primary Jets

IMPORTANT: Float needle and seat should be replaced as a set only.

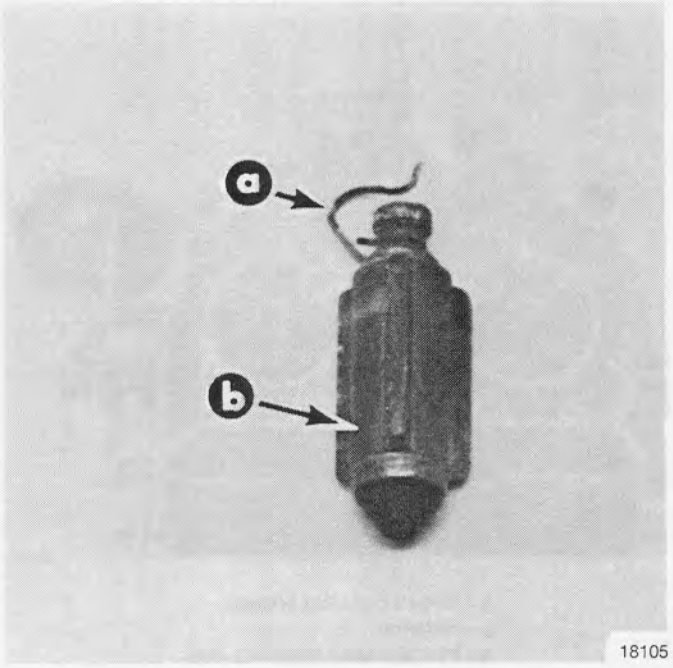
4. Install float needle seat and gasket. (Figure 7)



a - Float Needle Seat
b - Gasket

Figure 7. Installing Needle Seat and Gasket

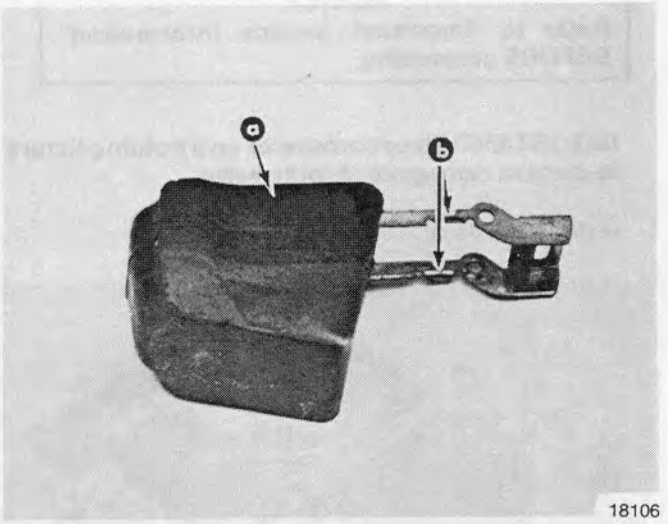
5. Installing float needle and float assembly.
   a. Install pull clip onto needle. (Figure 8)



a - Pull Clip
b - Needle

Figure 8. Installing Pull Clip on Needle

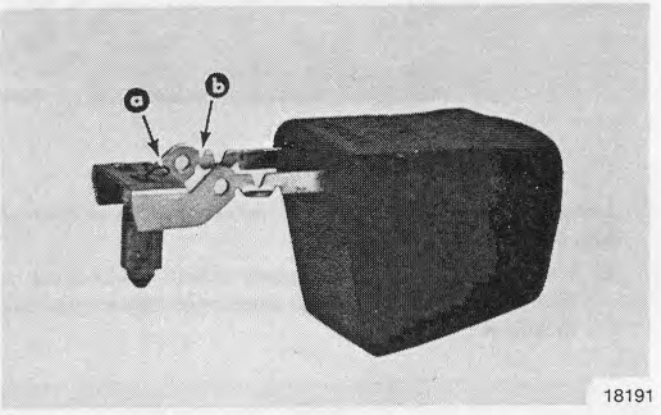
   b. If a new float or needle and seat are used, bend float arm slightly upward at notch for easier adjustment. (Figure 9)



a - Float
b - Float Arm Notch

Figure 9. Bending Float Arm

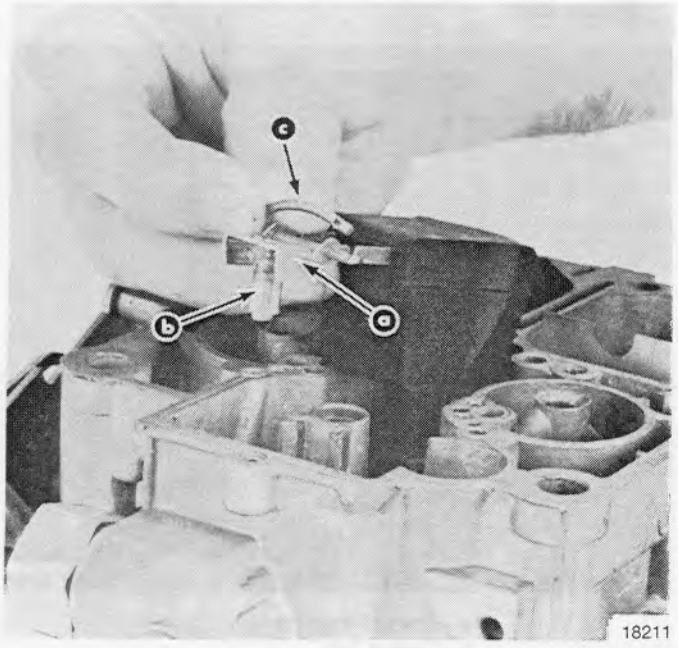
   c. Hook needle pull clip over edge of float arm closet to pontoon. (Figure 10)



a - Pull Clip
b - Float Arm

Figure 10. Proper Installation of Pull Clip

d. Install retaining pin into float arm and install float and needle into bowl. (Figure 11)



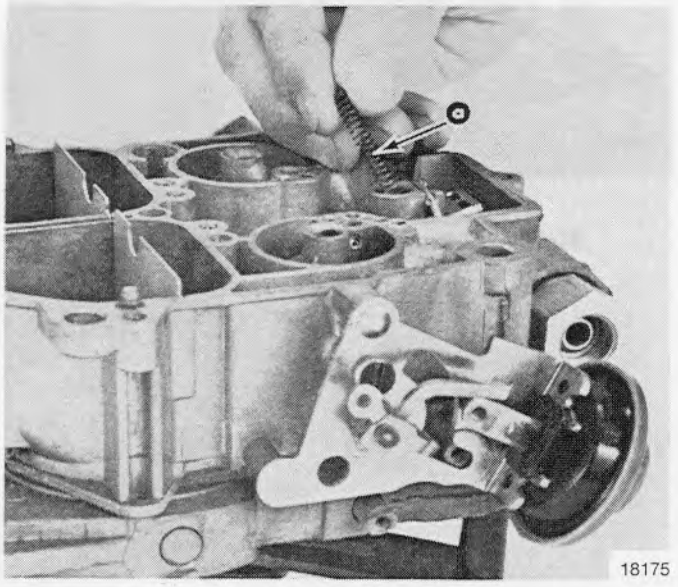
a - Float
b - Needle
c - Hinge Pin

Figure 11. Installing Float and Needle

IMPORTANT: Top of hinge pin must extend above casting by .010" (.25mm) for good pin retention.

e. Check float adjustment (refer to "Adjustment" in this section).

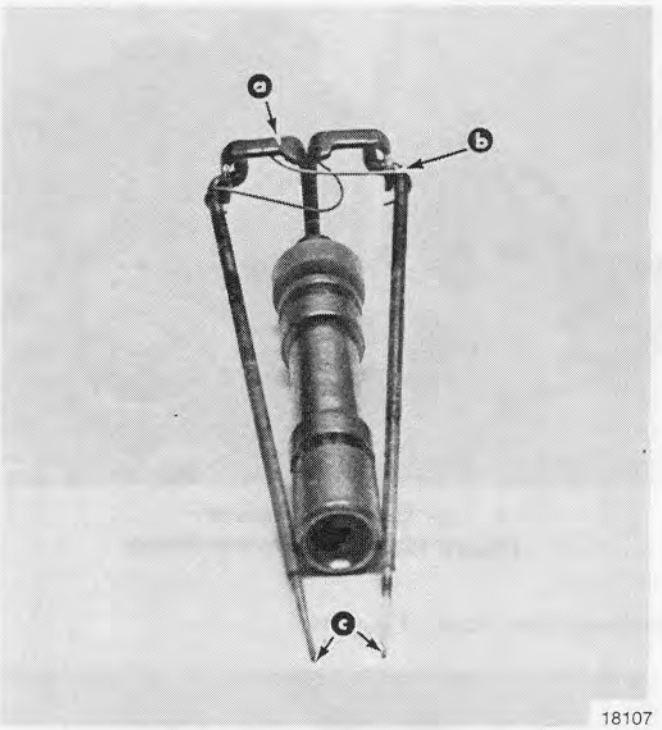
6. Install power piston spring. (Figure 12)



a - Power Piston Spring

Figure 12. Installing Power Piston Spring

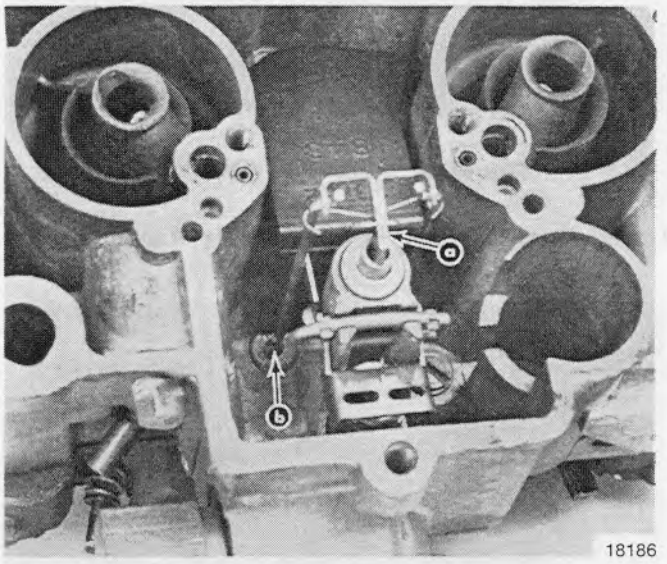
7. Install primary main metering rods in power piston hanger, and connect spring as shown. (Figure 13)



a - Power Piston Hanger
b - Tension Spring
c - Metering Rods

Figure 13. Installing Primary Metering Rods

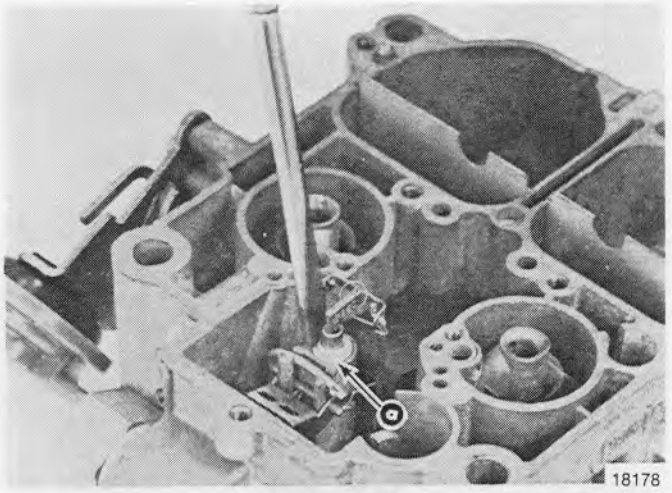
8. Install power piston assembly, guiding metering rod tips into main metering jets. (Figure 14)



a - Power Piston Assembly
b - Metering Rod Tip in Main Metering Jet

Figure 14. Installing Power Piston Assembly

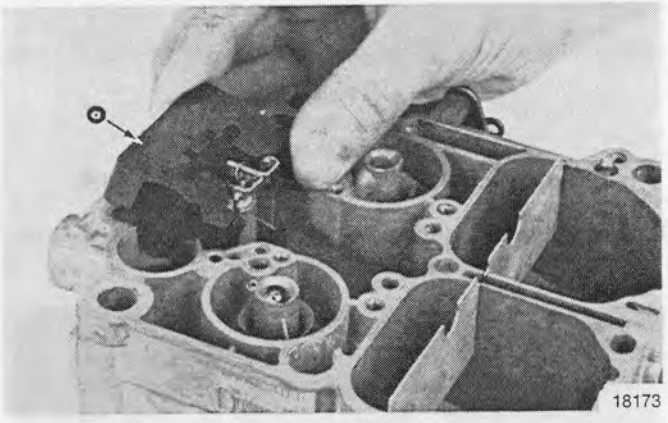
9. Push power piston retainer down until flush with casting. (Figure 15)



a - Power Piston Retainer

Figure 15. Seating Power Piston

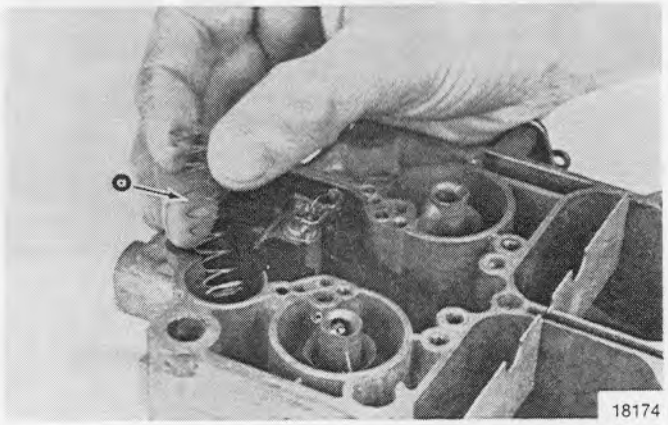
10. Install filler block. (Figure 16)



a - Filler Block

Figure 16. Installing Filler Block

11. Install accelerator pump plunger spring. (Figure 17)

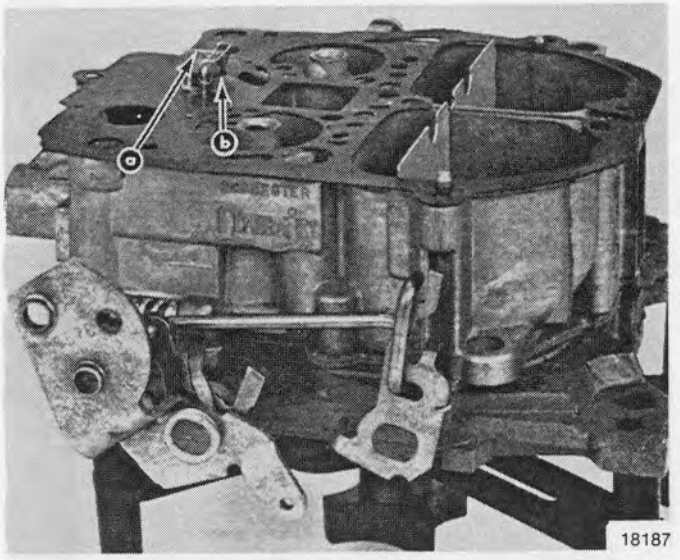


a - Spring

Figure 17. Installing Pump Return Spring

Air Horn

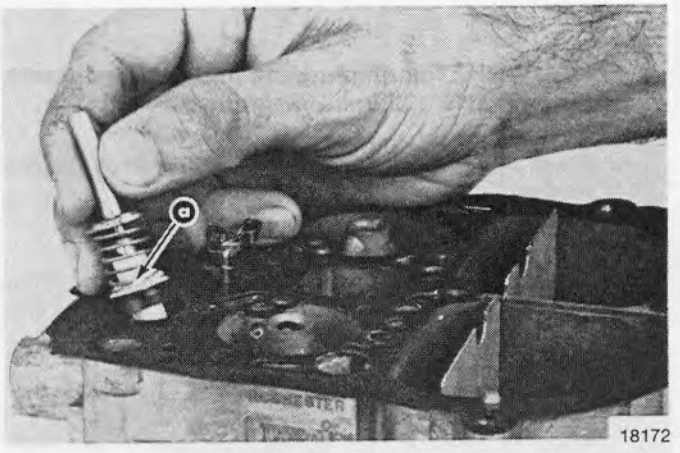
1. Install new gasket and slide tab under power piston hanger. (Figure 18)



a - Power Piston Hanger
b - Gasket Tab

Figure 18. Proper Installation of Gasket

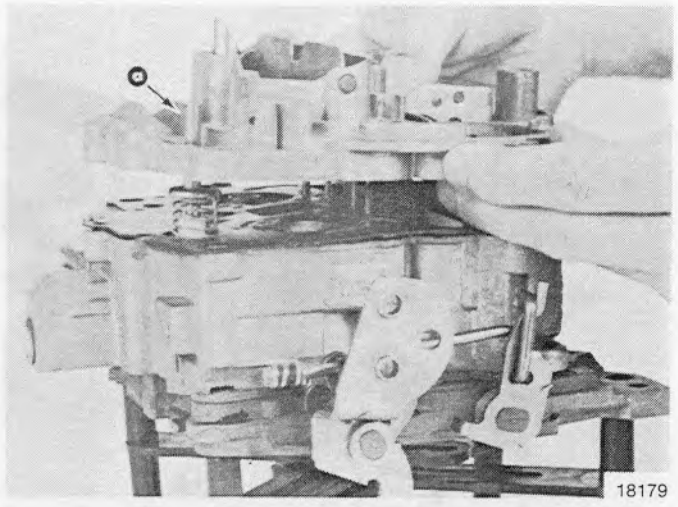
2. Install acceletor pump plunger. (Figure 19)



a - Plunger

Figure 19. Installing Accelerator Pump

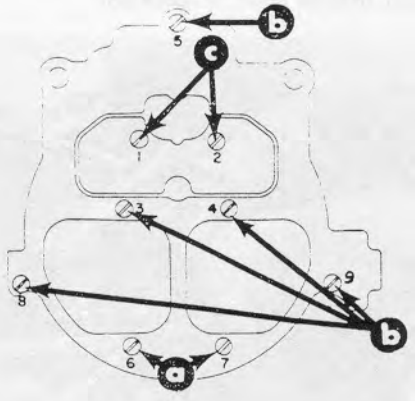
3. Install air horn. (Figure 20)



a - Air Horn

Figure 20. Installing Air Horn

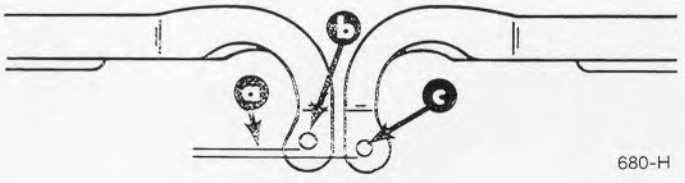
4. Install 9 attaching screws. Tighten securely in sequence as numbered. (Figure 21)



a - Long
b - Short
c - Countersunk

Figure 21. Attaching Screw Installation

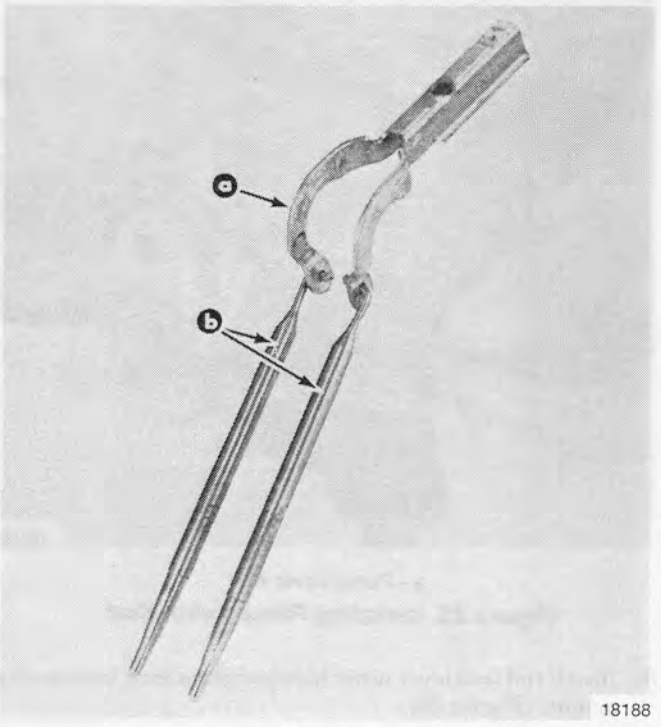
IMPORTANT: Hanger size may vary from specification chart. Manufacturer varies hanger size to make up differences in carburetor castings. Always install the same size hanger as was removed from the carburetor. Difference in hangers is the hole location, (Figure 22), which affects secondary fuel metering.



a - Hole Location Changes Fuel Metering
b - Richer
c - Leaner

Figure 22. Hanger Size

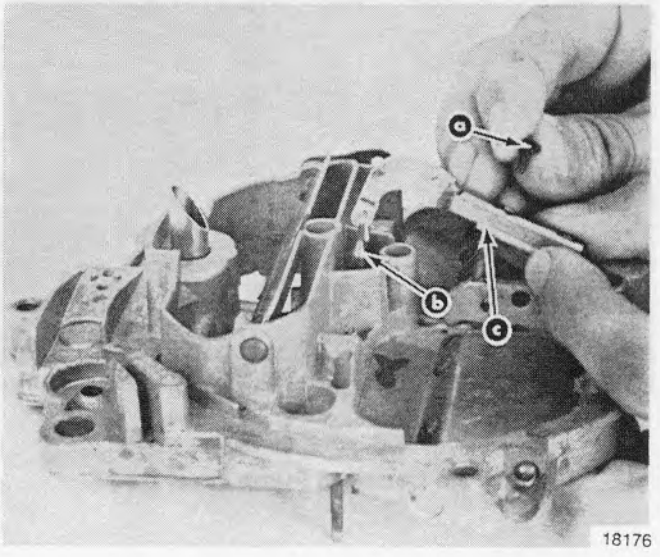
5. Install secondary metering rods into hanger with upper ends toward each other as shown. (Figure 23)



a - Hanger
b - Metering Rods

Figure 23. Installing Metering Rods

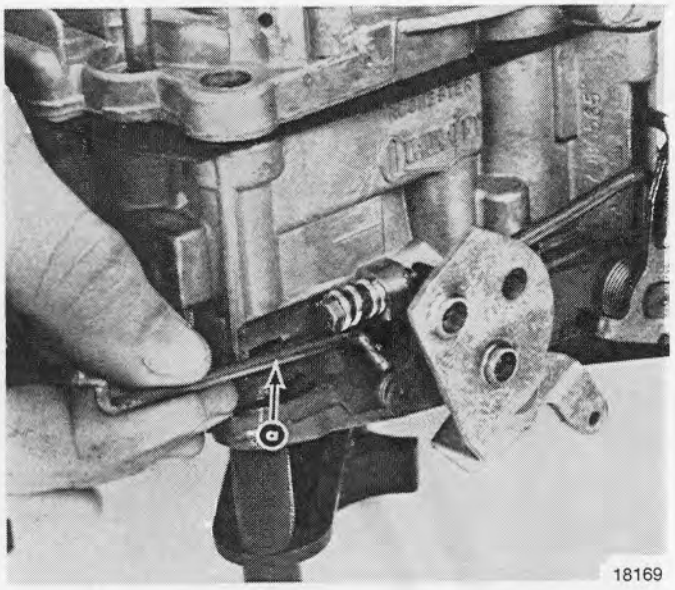
6. Install metering rods and hanger and secure with screw. Tighten securely. (Figure 24)



a - Screw
b - Metering Rods
c - Hanger

Figure 24. Installing Hanger Assembly

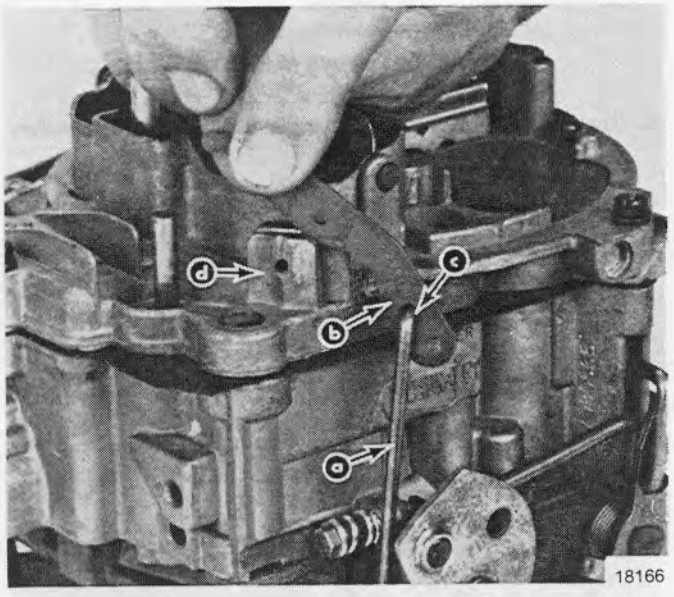
7. Install pump lever rod. (Figure 25)



a - Pump Lever Rod

Figure 25. Installng Pump Lever Rod

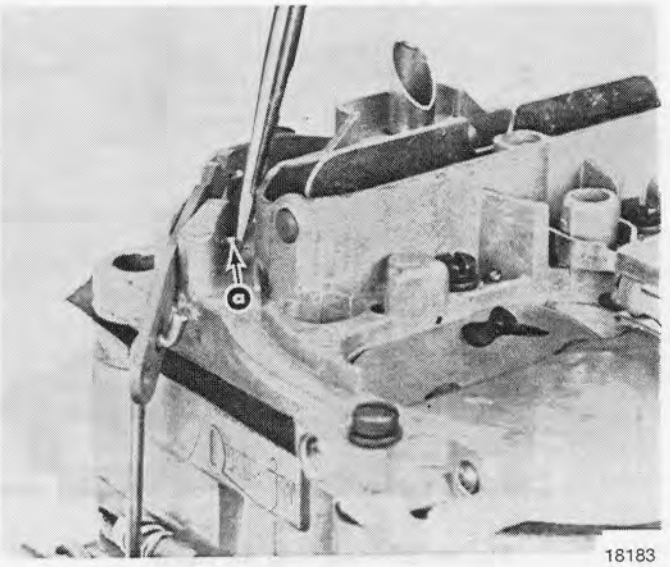
8. Install rod into lever inner hole and place lever into casting mount. (Figure 26)



a - Rod
b - Lever
c - Inner hole
d - Casting Mount

Figure 26. Locating Pump Lever Rod

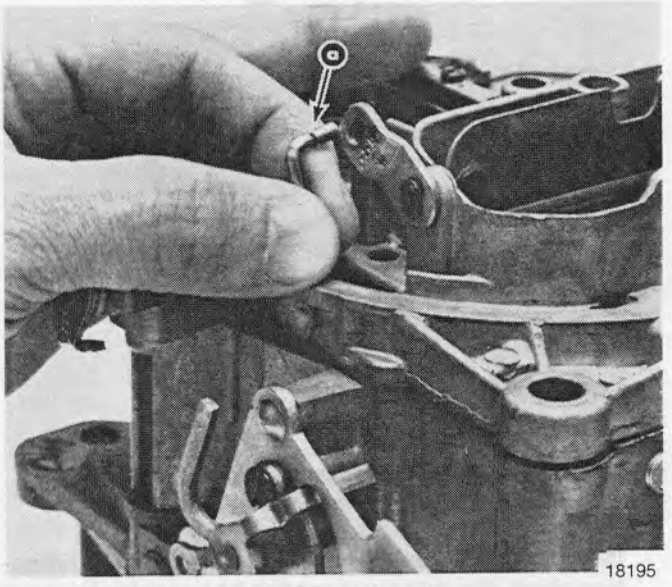
9. Press roll pin into place using a screwdriver.



a - Roll Pin

Figure 27. Installing Roll Pin

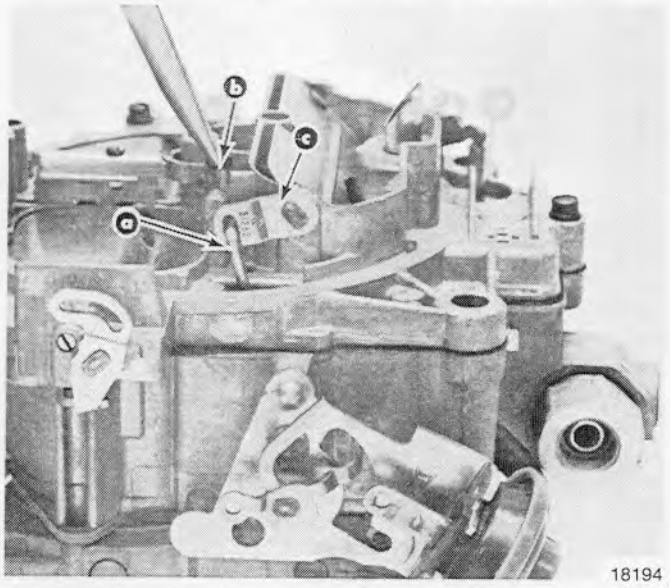
10. Install bottom end of choke shutter rod into intermediate choke lever in float bowl. (Figure 28)



a - Choke Shutter Rod

Figure 28. Install Choke Shutter Rod to Intermediate Choke Lever

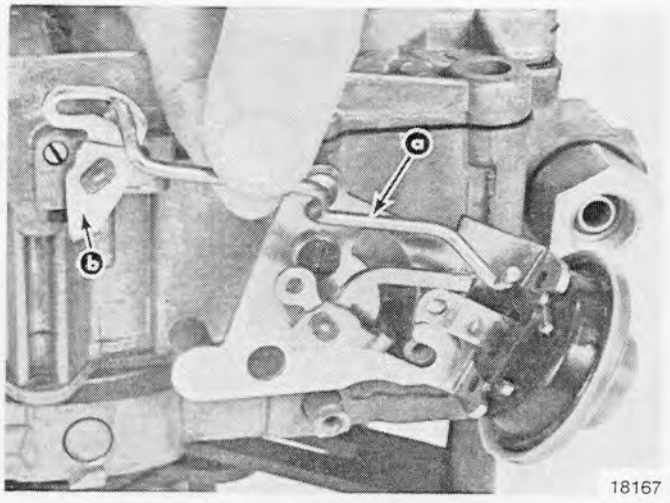
11. Install upper end of choke shutter rod into the choke blade lever, install clip onto choke shutter rod. (Figure 29)



a - Choke Shutter Rod b - Clip c - Choke Blade Lever

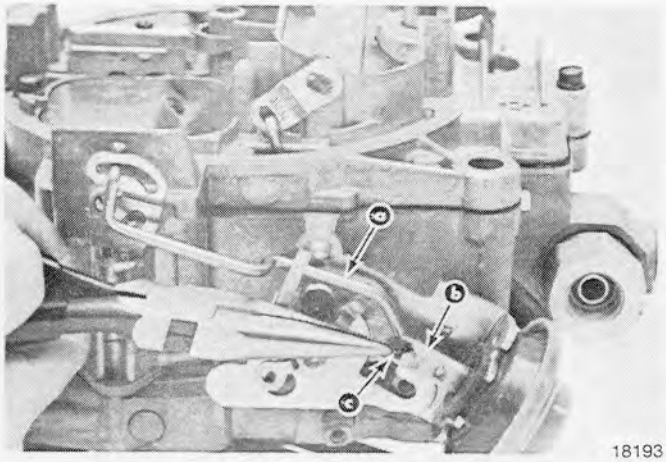
Figure 29. Installing Upper End of Choke Shutter Rod

12. Install rod into air valve lever. (Figure 30)

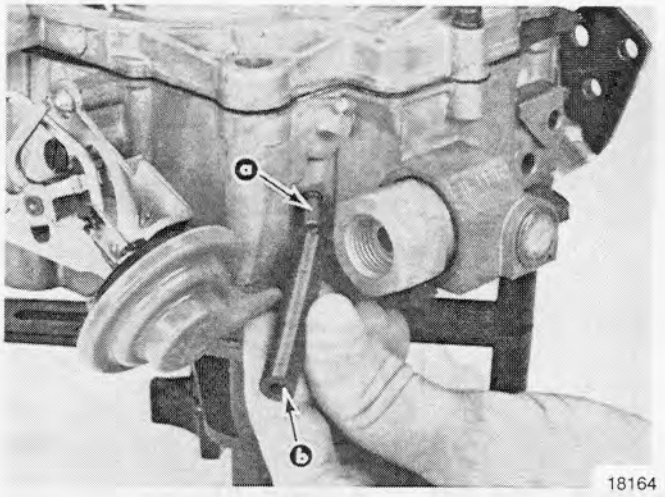


a - Rod b - Air Valve Lever

Figure 30. Installing Air Valve Rod



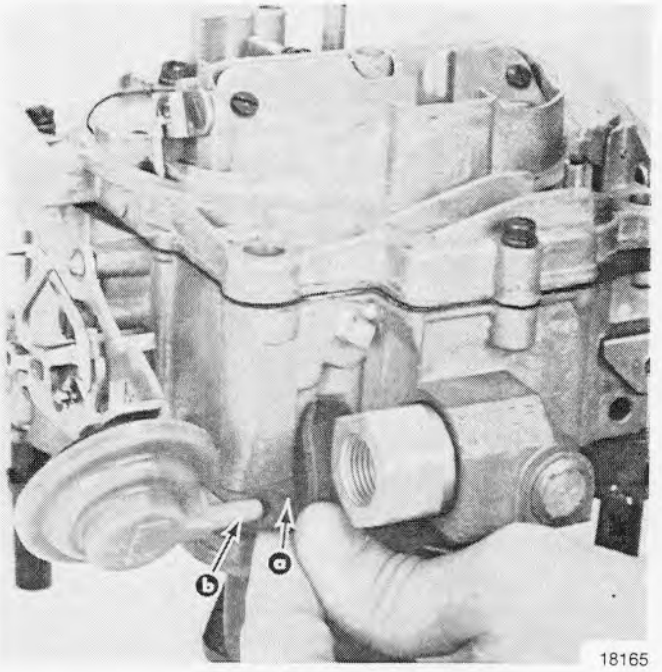
13. Install rod into vacuum break arm and install clip. (Figure 31)
14. Install vacuum break hose onto carburetor fitting. (Figure 32)



a - Fitting
b - Hose

Figure 32. Installing Vacuum Hose

15. Install vacuum break hose onto vacuum dashpot fitting. (Figure 33)



a - Hose
b - Dashpot Fitting

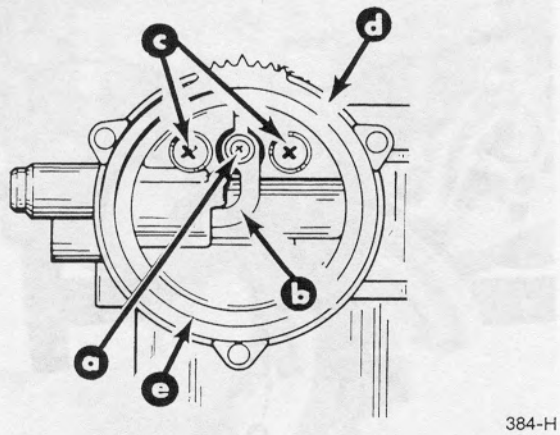
Figure 33. Installing Vacuum Hose to Dashpot

a - Rod
b - Vacuum Break Arm
c - Clip

Figure 31. Installing Rod to Break Arm

ELECTRIC CHOKE (4MC CARBURETORS)

1. Install choke housing assembly. Tighten securely.

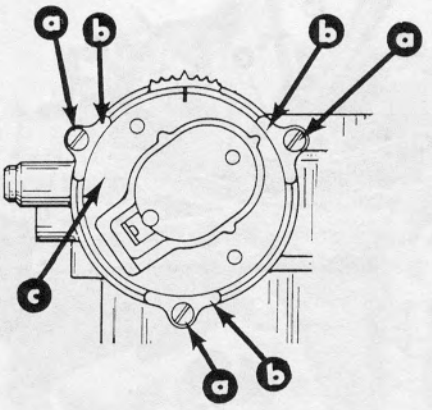


384-H

a - Screw - Choke Lever
b - Choke Lever
c - Screws - Choke Housing Assembly
d - Gasket - If Equipped (Not Visible)
e - Choke Housing Assembly

Figure 34. Installing Choke Housing and Lever

2. Install choke lever and screw. Tighten securely.
3. Install choke cover, retainers, lockwashers, and screws. Adjust choke to specifications. Tighten screws securely.



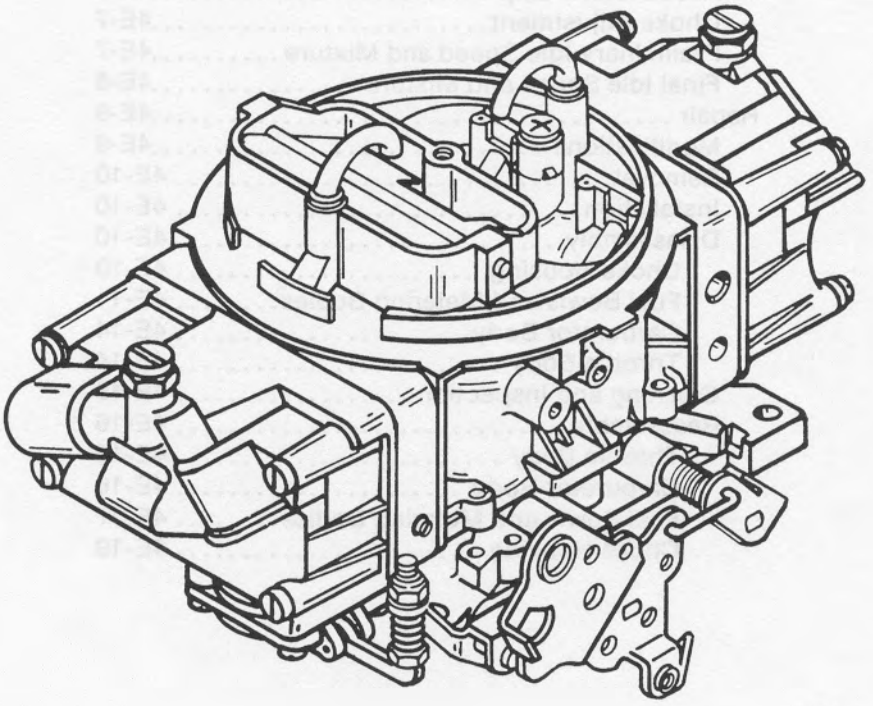
384-H

a - Screws
b - Retainer
c - Choke Cover

Figure 35. Installing Choke Cover

SECTION 4 - FUEL SYSTEM

PART E - HOLLEY 4 BARREL



681-H

MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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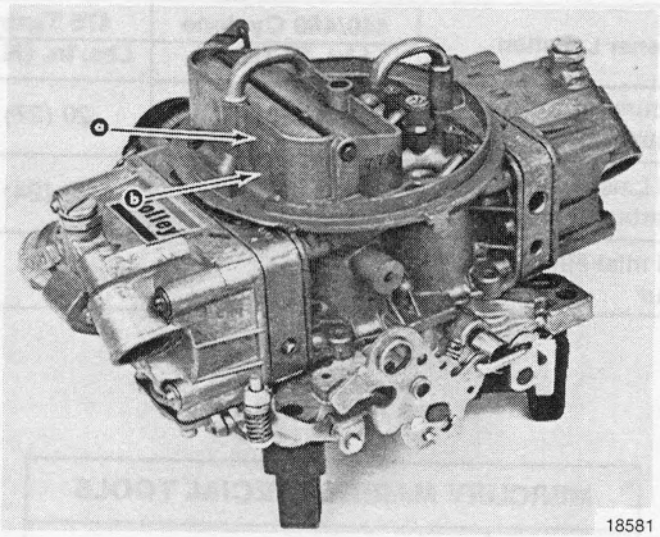
IDENTIFICATION



18581

a - Part Number
b - "MOD" (440/460 Cyclone Only)

Figure 1. Holley Part Number Location

REPLACEMENT PARTS WARNING

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

TORQUE SPECIFICATIONS

Fastener Location	440/460 Cyclone Lbs. Ft. (N.m)	475 Turbo Lbs. In. (N.m)
Carburetor to Manifold	20 (27)	20 (27)
Fuel Line To Carburetor	18 (24)	18 (24)
Fuel Inlet Filter Nut	Securely	

TOOLS

MERCURY MARINE SPECIAL TOOLS	
91-59339	Tachometer
91-36392	Universal Carburetor Gauge

BORROUGHS TOOLS AND EQUIPMENT 2429 N. BURDICK ST. KALAMAZOO, MICHIGAN 49007 (616) 345-5163	
BT8128B	Float Gram Scale

SPECIFICATIONS

Engine Model	440/460 Cyclone	475 Turbo
Make	Holley	Holley
Model	4150	4150
Holley Part No.	4781	9022
Mercury Part No.	1393-8862	1374-1802
Main Primary Jets	.84	.072
Main Secondary Jets	.084	.094
Accelerator Pump	.015 (.4mm)	.015 (.4mm)
Accelerator Pump Check Ball	.015" (4mm)	.015" (4mm)
Float Adjustment	Bottom of Sight Plug Hole ±1/32" (.8mm)	Bottom of Sight Plug Hole ±1/32" (.8mm)
Float Weight	15.6 Grams Max.	15.6 Grams Max.
Choke Setting	Index Marks Aligned	Index Marks Aligned
Preliminary Idle Mixture Setting	2 Turns	2 Turns

DESCRIPTION

The model 4150 is a 4 bore Holley carburetor with an electrically operated automatic choke. The Holley model 4150 is a dual feed, double pump carburetor. This means each fuel bowl has a seperate fuel inlet and there 2 accelerator pumps, one for the primary side and one for the secondary side. Between the fuel bowls and the carburetor body, metering bodies are located. The metering bodies contain the main jets, power valve, and the majority of the metered passages in the carburetor. Both the primary and secondary floats have an external float adjustment.

PRECAUTIONS

⚠WARNING

Alway disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that igntion key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION

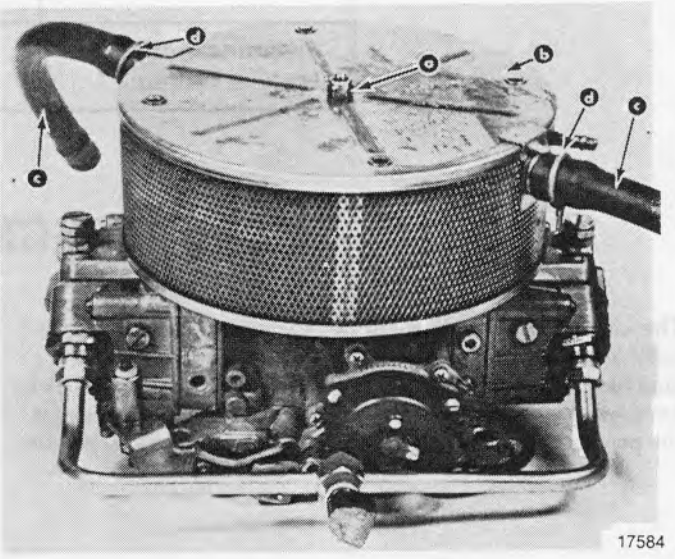
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

MAINTENANCE

Refer to "Precautions", in this section, BEFORE proceeding.

FLAME ARRESTOR

1. Remove in the following order: Figure 1
   a. Nut.
   b. Washer. (Not Shown)
   c. Hose clamps and crankcase ventilation hoses - From flame arrestor and rocker arm covers.
   d. Flame arrestor - Lift from carburetor
2. Clean and inspect: Figure 1
   a. Clean flame arrestor by blowing it out with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, replace if necessary.
3. Install in the following order: Figure 1
   a. Flame arrestor - Place on carburetor.
   b. Crankcase ventilation hoses and clamps - To flame arrestor and rocker arm covers.
   c. Washer (Not Shown).
   d. Nut - Tighten securely, do not overtighten.



a - Nut
b - Flame Arrestor
c - Crankcase Ventilation Hoses
d - Clamps

Figure 1. Flame Arrestor

FUEL FILTERS

Refer to "Precautions", in this section, BEFORE proceeding.

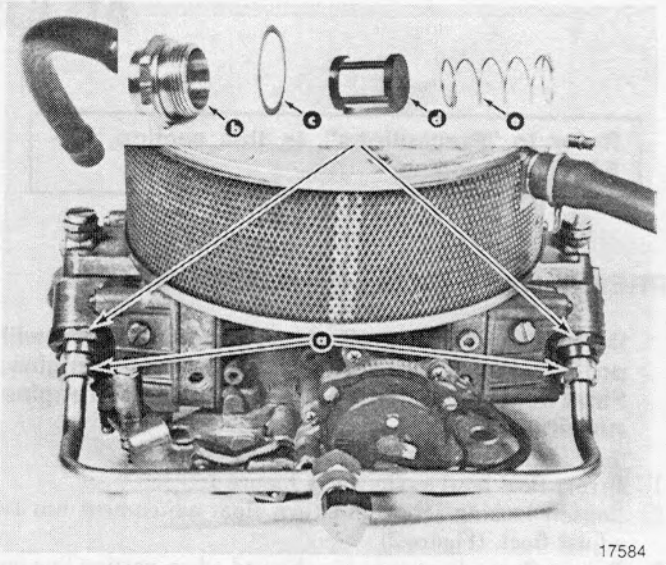
Carburetor inlet filters are located in float chamber assemblies behind fuel inlet fittings (Figure 2). To replace filters proceed as follows:

1. Remove fuel line from fuel inlet filter nuts.
2. Remove fuel inlet filter nut, gasket, filter and spring from each float chamber assembly. (Discard gasket and filter.)
3. Clean nuts and springs in solvent and dry with compressed air.
4. Install spring, new filter (with open end outward), gasket and fuel inlet filter nut into each float chamber assembly (in that order). Tighten nut securely.
5. Reconnect fuel line and tighten securely.
6. Run engine and check for gasoline leaks.

CHOKE INSPECTION

The choke does not require any periodic maintenance; however, if a choke malfunction is suspected, the following should be done:

1. With engine off, remove flame arrestor.
2. Open and close choke several times, and check for binding, loose or disconnected linkages, or other signs of damage.
3. If choke or linkage binds, sticks, or works sluggishly, clean with carburetor choke cleaner. Carefully follow directions on can.



a - Fuel Line Fittings
b - Fuel Filter Nut
c - Filter Nut Gasket
d - Filter
e - Spring

Figure 2. Fuel Inlet Filter

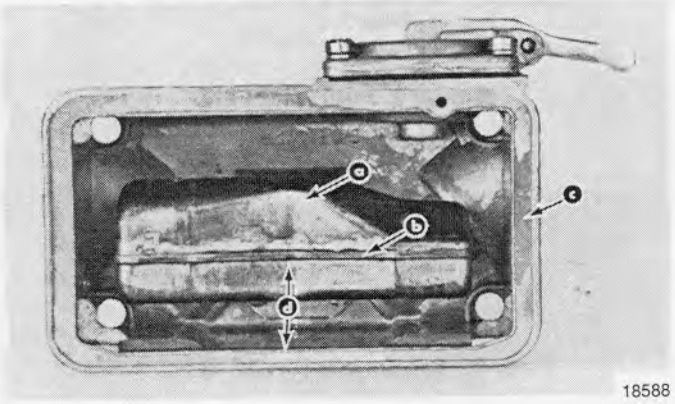
ADJUSTMENTS

Refer to "Precautions", in this section, BEFORE proceeding.

PRELIMINARY FLOAT ADJUSTMENT

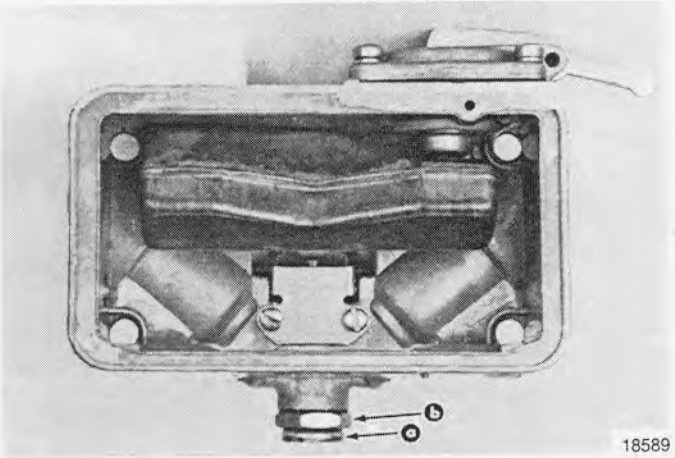
IMPORTANT: The preliminary float adjustment will provide a sufficient setting for starting the engine. Final float adjustments MUST be made with engine running.

1. Invert float bowl as shown in Figure 1.
2. Loosen locking screw and turn float adjustment nut to adjust float. (Figure 2)
3. Proper float adjustment is achieved when parting line on float is parallel with fuel bowl. Parting line must be parallel all the way around float.



a - Float
b - Float Parting Line
c - Fuel Bowl (Inverted)
d - Parallel All The Way Around Float

Figure 1. Preliminary Float Setting



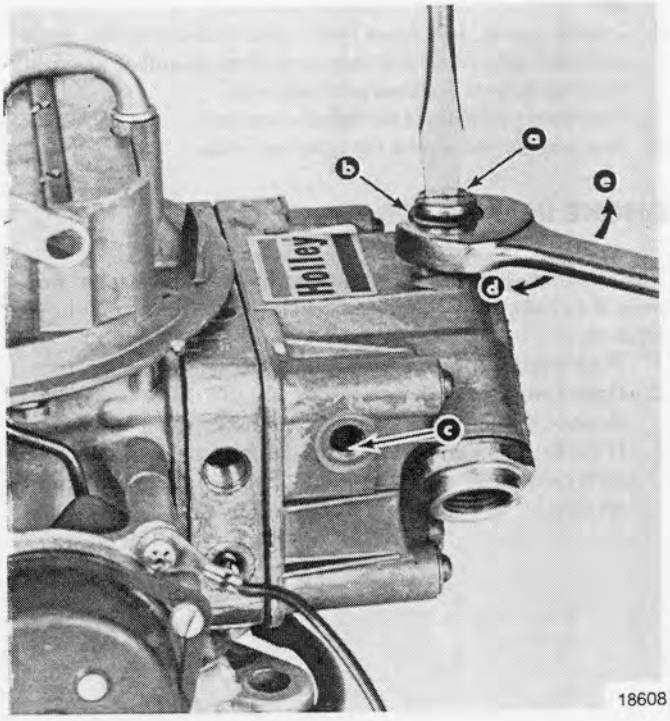
a - Locking Screw
b - Adjustment Nut

Figure 2. Adjusting Float Level

4. Repeat this procedure for both floats.

FINAL FLOAT ADJUSTMENT

1. With carburetor mounted on engine, start engine and leave run for several minutes.
2. While engine is running remove sight plug on primary fuel bowl. (Figure 3)
3. Loosen locking screw and turn adjustment nut slowly until fuel can be seen even with the bottom of the sight plug hole.



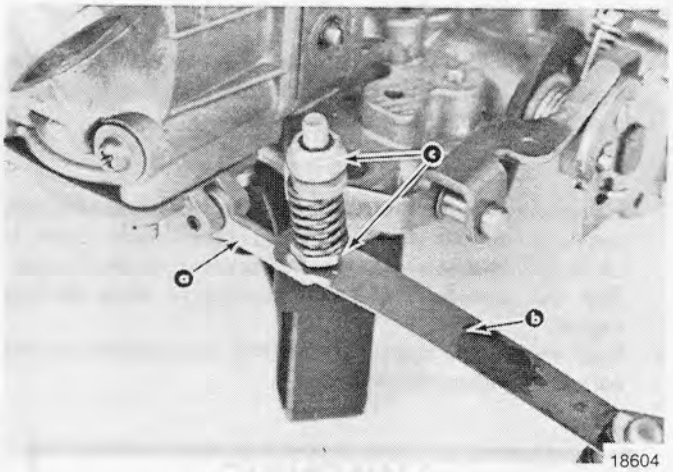
a - Locking Screw
b - Adjustment Nut
c - Sight Plug Hole
d - Raises Fuel Level
e - Lowers Fuel Level

Figure 3. Final Float Adjustment

4. Tighten locking screw securely being careful not to let adjustment nut turn. (Figure 3)
5. Reinstall sight plug and gasket.
6. Repeat this procedure for secondary side of carburetor.

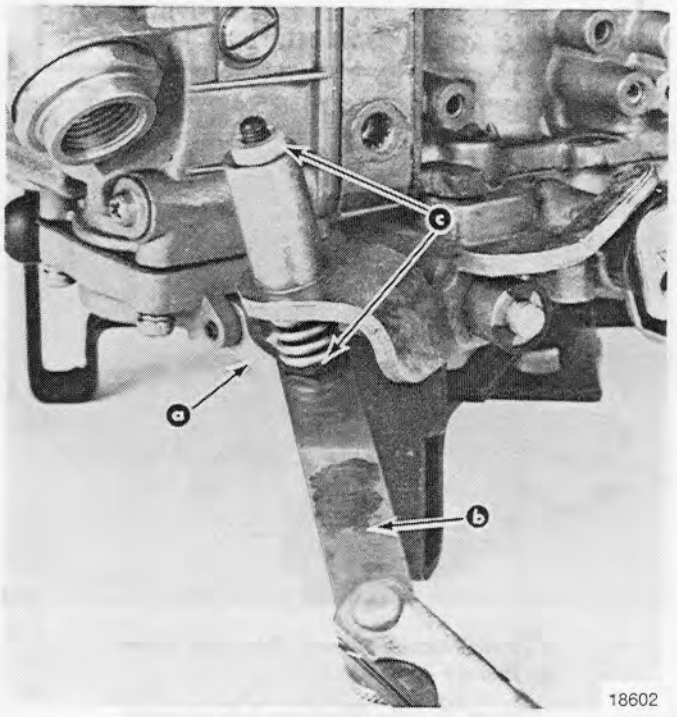
ACCELERATOR PUMP

1. With engine shut off, move throttle arm to W.O.T. position.
2. While holding throttle arm in W.O.T. position push down on primary accelerator pump lever. (Figure 4)
3. With a feeler gauge check for clearance between adjustment screw and accelerator pump lever. Adjust screw and nut to specifications.
4. Repeat procedure for secondary accelerator pump. (Figure 5)



a - Pump Lever - Push Down
b - Feeler Gauge
c - Adjustment Screw and Nut

Figure 4. Primary Accelerator Pump Adjustment

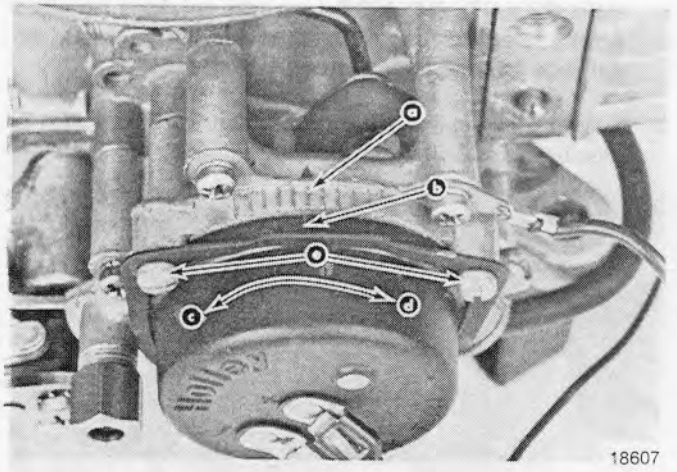


a - Pump Lever - Push Down
b - Feeler Gauge
c - Adjustment Screw and Nut

Figure 5. Secondary Accelerator Pump Adjustment

CHOKE ADJUSTMENT

1. Normal choke setting is such that scribed mark on choke cover is in line with center mark on choke housing.



a - Choke Housing Mark
b - Choke Cover Mark
c - Richer Adjustment
d - Leaner Adjustment
e - Cover Retaining Screws (One Not Shown)

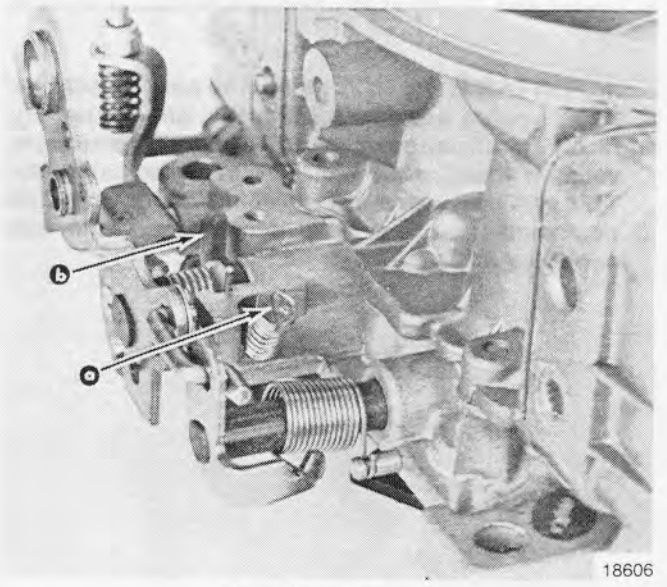
Figure 6. Choke Adjustment

2. If choke adjustment is necessary (Figure 6):
   a. Loosen 3 choke cover retaining screws and adjust as shown.
   b. Tighten 3 choke cover retaining screws securely.

PRELIMINARY IDLE SPEED and MIXTURE

IMPORTANT: The following adjustments will provide a sufficient setting to start engine. Final adjustments MUST BE made with engine running.

1. Turn idle speed screw in until it just contacts idle cam, then turn screw in one additonal turn. (Figure 7)

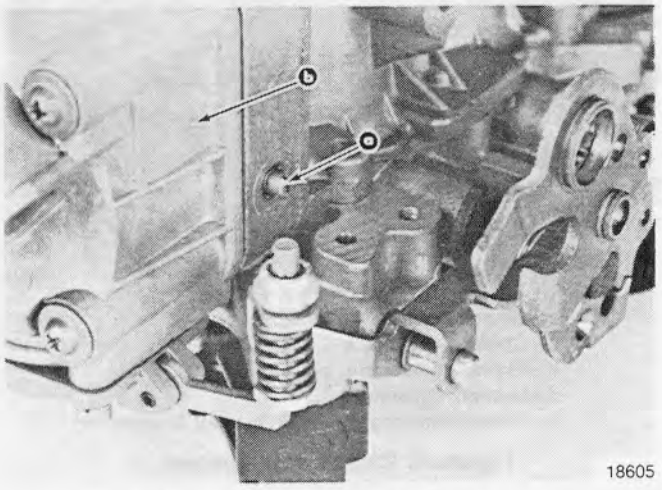


a - Idle Speed Screw
b - Idle Cam

Figure 7. Idle Speed Screw

IMPORTANT: DO NOT turn idle mixture needles tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needles in until they LIGHTLY SEAT: then back out 2 turns. (Figure 8)



a - 2 Idle Mixture Screws - Only One Shown
b - Primary Fuel Bowl

Figure 8. Idle Mixture Screws

FINAL IDLE SPEED and MIXTURE

IMPORTANT: Boat MUST BE in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under "Specifications", following, with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, procced as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

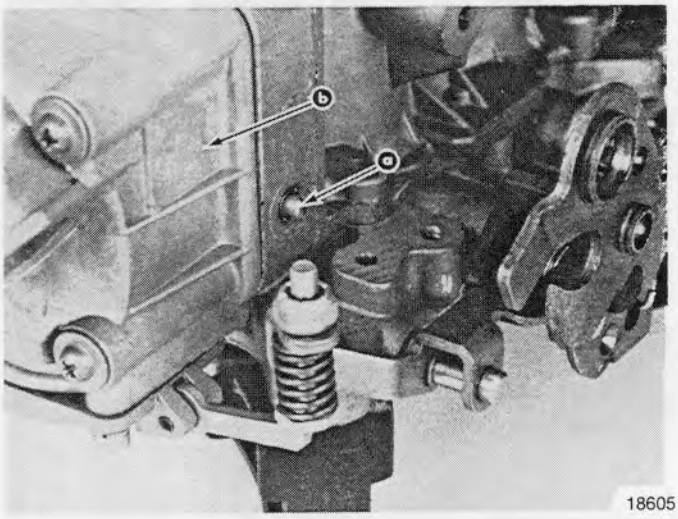
1. Connect a shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needle (Figure 9) tightly into seat (in next step), as damage to needle and/or seat may result.

2. If a new or rebuilt carburetor has been installed, turn idle mixture needles (Figure 9) in (clockwise) unitl it LIGHTLY contacts seat; then, back out needle 2 turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

DO NOT leave the helm unoccupied while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

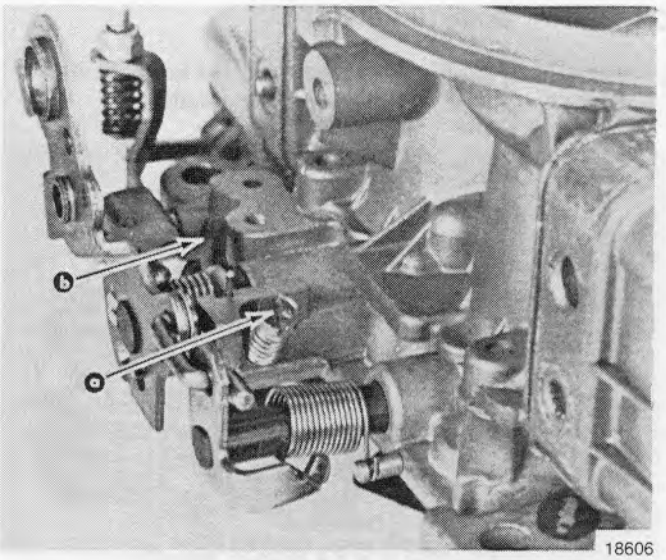


a - 2 Idle Mixture Screws - Only One Shown
b - Primary Fuel Bowl

Figure 9. Idle Mixture Adjustment

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable brass barrel from anchor stud.
6. Adjust idle speed adjustment screw (Figure 10) to obtain specified RPM.
7. With engine running at specified RPM, adjust idle mixture needle (Figure 9), as follows:
   a. Turn idle mixture needle inward (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw outward (counterclockwise) until the speed begins to drop due to a rich mixture.
   c. Turn screw inward to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Repeat procedure with other needle.
   e. Readjust idle speed adjusting screw, if necessary, to obtain specified RPM.

IMPORTANT: Refer to "Section 2, Part H" for throttle cable installation and adjustment.



a - Idle Speed Screw
b - Idle Cam

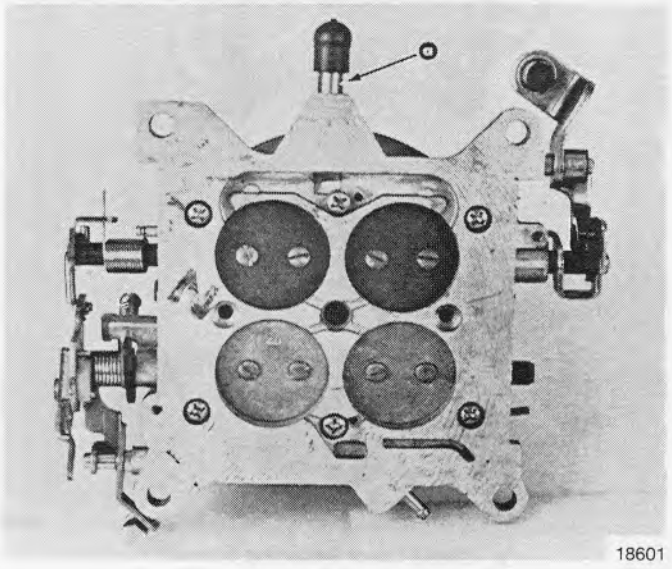
Figure 10. Idle Speed Adjustment

REPAIR

Refer to "Precautions", in this section, BEFORE proceeding.

MODIFICATIONS

IMPORTANT: There has been several modifications made to the Holley carburetor used on the 440/460 Cyclone. The carburetor will have "MOD" etched into casting at location shown in "Identification "photo.



a - Vacuum Tube is Removed

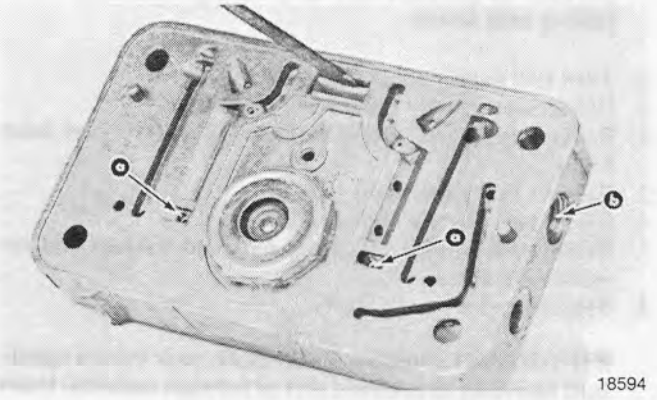
Figure 1. 440/460 Cyclone Only

Throttle Body (Figure 1)

1. Vacuum tube is removed and a ⅛" NPT pipe plug is installed.

Primary Metering Body (Figure 2)

1. The idle feed holes are drilled to .040".
2. A ⅛" NPT pipe plug is installed in the vacuum hole.
3. .084" jets are installed in both the primary and secondary metering blocks.

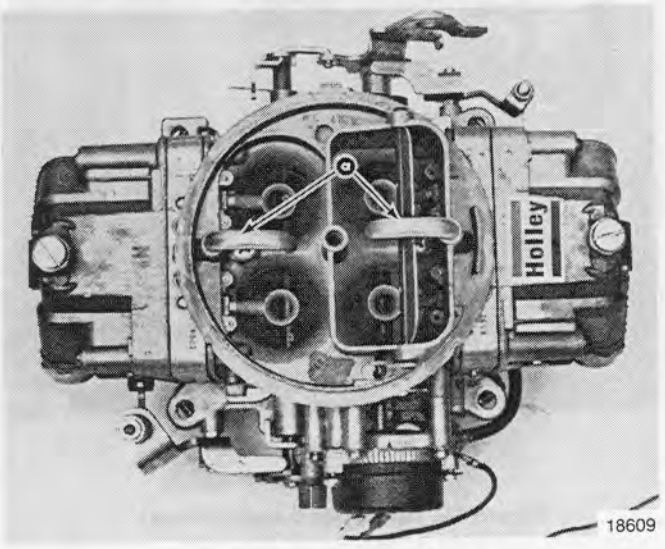


a - Idle Feed Holes
b - Plug Installed in This Hole

Figure 2. 440/460 Cyclone Only

Carburetor Body (Figure 3)

1. The original bowl vents are removed, the holes are drilled to .316" and new "J" tube vents are installed.



a - New "J" Tube Bowl Vents

Figure 3. 440/460 Cyclone and 475 Turbo

REMOVAL

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

1. Remove crankcase ventilation hoses from flame arrestor; then, remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove fuel lines. Refer to Figure 1 under "Fuel Inlet Filter".
5. Remove fuel pump sight tube.
6. Disconnect electric choke.
7. Remove carburetor attaching nuts and washers and remove carburetor.
8. Remove and discard gaskets.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

INSTALLATION

1. Thoroughly clean gasket surfaces. Use care to prevent gasket material from entering intake manifold.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to specifications.
3. Connect fuel lines to fuel inlet nuts and torque to specifications.
4. Connect fuel pump sight tube.
5. Connect electric choke wires to choke cover.
6. Move throttle lever back-and-forth and check for binding in throttle linkage.
7. Install throttle cable, as explained, in "Section 2, Part H".
8. Install flame arrestor and crankcase ventilation hoses.
9. Reconnect battery cables to battery.
10. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
11. Adjust idle speed and idle mixture, as outlined under "Adjustments", preceding.

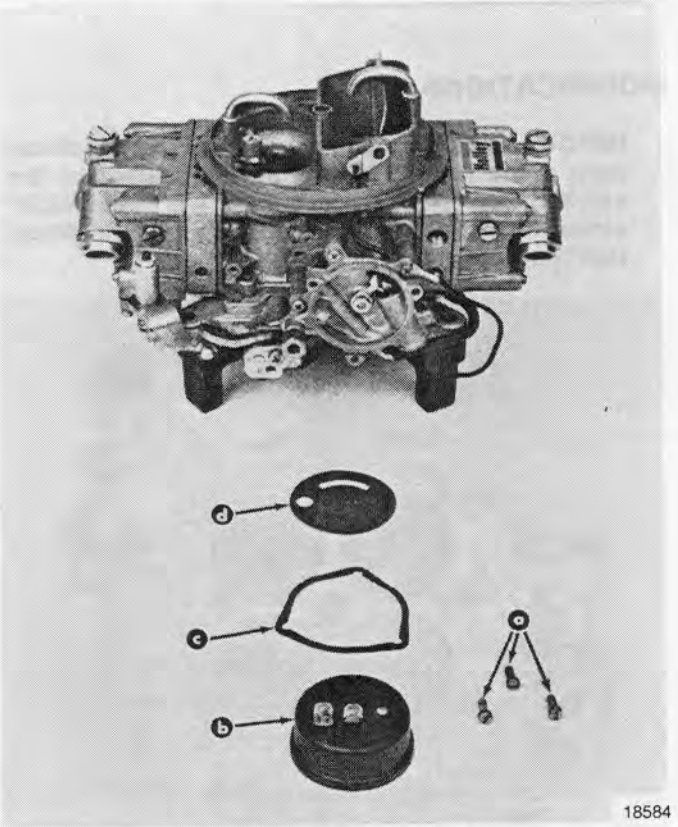
DISASSEMBLY

The following is a step-by-step procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessry steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

Choke Housing

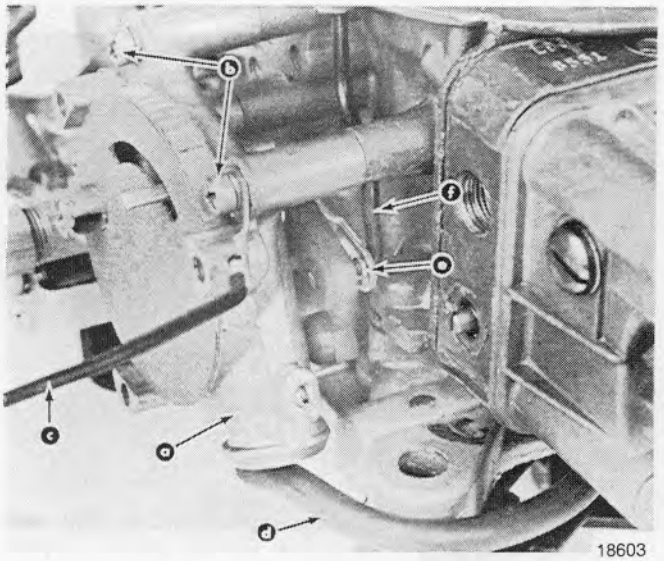
1. Remove choke cover. (Figure 1)



a - Choke Cover Retaining Screws
b - Choke Cover
c - Choke Cover Retainer
d - Gasket

Figure 1. Removing Choke Cover

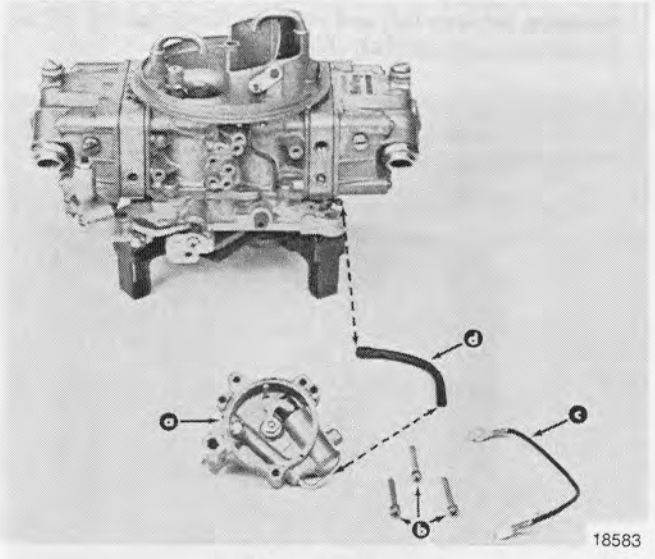
2. Remove choke rod retaining clip. (Figure 2)



a - Choke Housing
b - Housing Retaining Screws
c - Ground Wire
d - Vacuum Hose
e - Choke Rod Retaining Clip
f - Choke Rod

Figure 2. Removing Choke Rod Retaining Clip

3. Remove choke housing. (Figure 3)



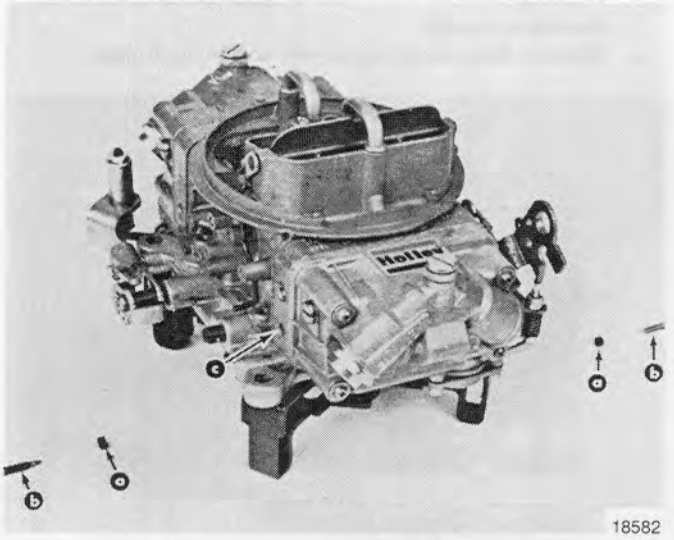
a - Choke Housing
b - Retaining Screws
c - Ground Wire
d - Vacuum Hose

Figure 3. Removing Choke Housing

Fuel Bowls and Metering Bodies

IMPORTANT: As the rest of the carburetor is disassembled all of the parts from the primary side (of the carburetor) should be kept seperated from secondary side parts. This will assure all of the parts are installed properly upon reassembly.

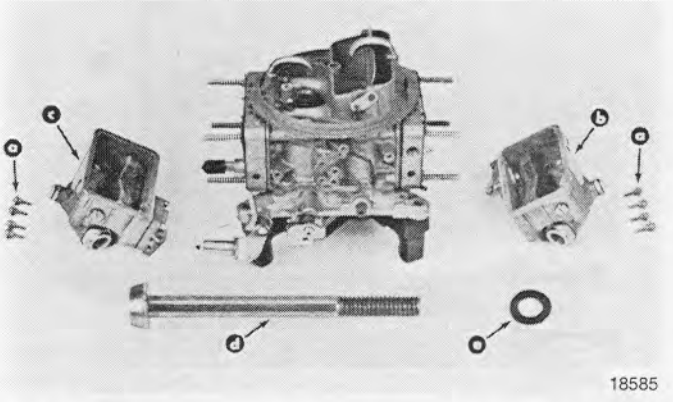
1. Remove fuel inlet filter nuts, gaskets, filters, and springs as outlined.
2. Remove idle mixture screws and gaskets. (Figure 4)



a - Gaskets
b - Idle Mixture Screws
c - Idle Mixture Chamber (Only 1 Shown)

Figure 4. Removing Idle Mixture Screws

3. Remove primary and secondary fuel bowls. (Figure 5)

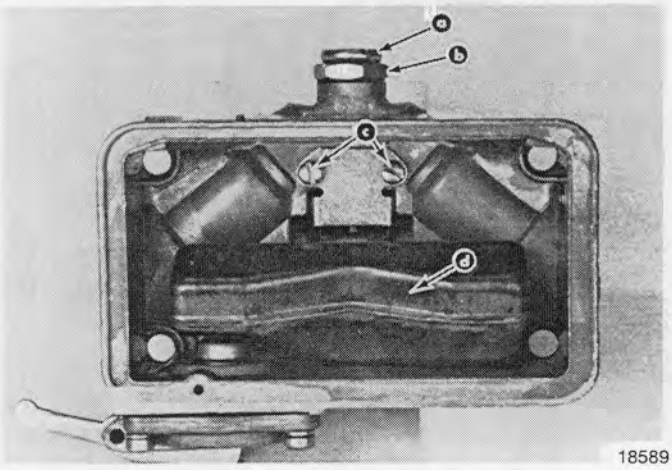


a - Fuel Bowl Retaining Screws and Gaskets (Gaskets Not Shown) Used on 475 Turbo
b - Primary Fuel Bowl
c - Secondary Fuel Bowl
d - Screws Used on 440/460 Cyclone
e - Gasket

Figure 5. Removing Fuel Bowls

IMPORTANT: Carburetors used on the 440/460 Cyclone engines will have long thru-bolts holding the fuel bowls onto the carburetor. Early carburetors used on the 475 Turbo engine will be as shown in Figure 5. Later models may have long thru-bolts also.

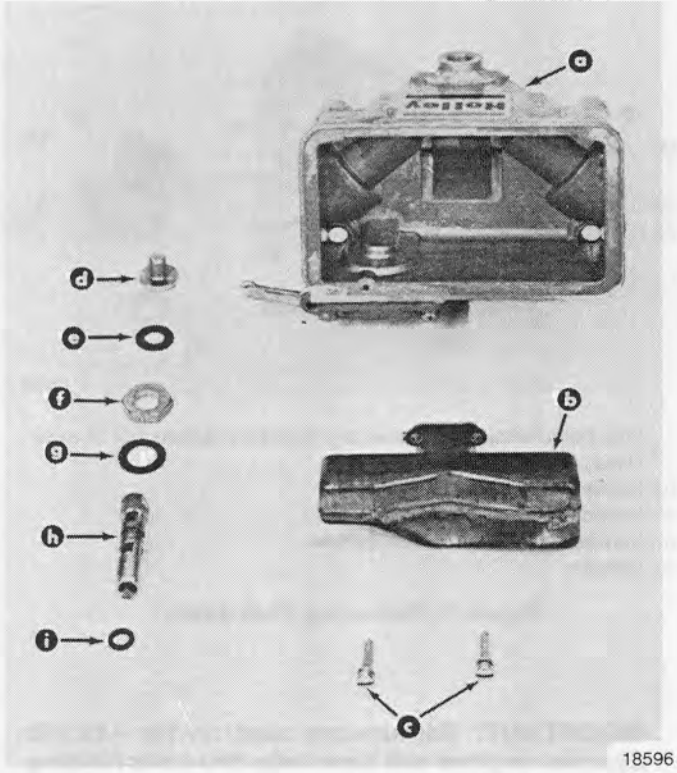
4. Remove needle seat and float assembly from fuel bowls. (Figures 6 and 7)
   a. Loosen locking screw.
   b. Turn adjustment nut counterclockwise to remove needle seat assembly.
   c. Remove float retaining screws and remove float.



a - Locking Screw
b - Adjustment Nut
c - Float Retaining Screws
d - Float

Figure 6. Removing Needle Seat and Float

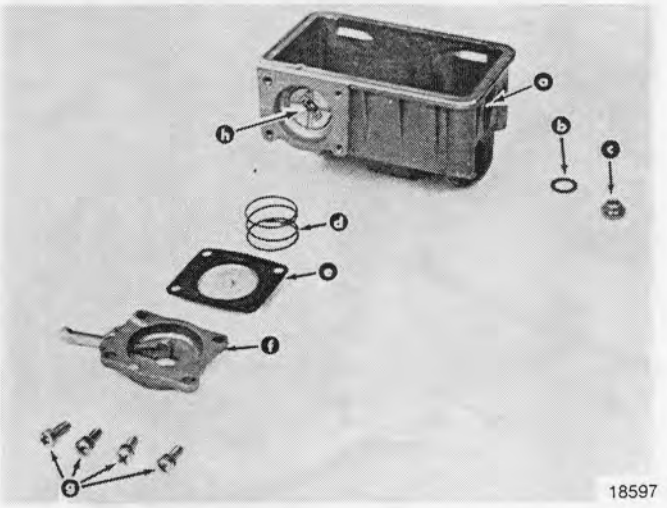
IMPORTANT: Needle seat and needle are factory assembled and must be serviced as an assembly.



a - Fuel Bowl
b - Float
c - Float Retaining Screws
d - Locking Screw
e - Gasket
f - Adjustment Nut
g - Gasket
h - Needle and Seat Assembly
i - "O" Ring

Figure 7. Needle and Seat and Float Assembly Removed

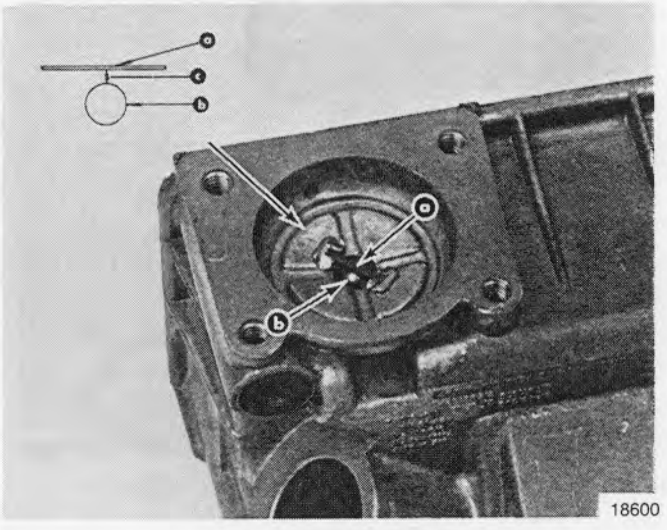
4. Remove accelerator pump assembly, sight plug and gasket. (Figure 8)



a - Fuel Bowl
b - Gasket
c - Sight Plug
d - Pump Return Spring
e - Pump Diaphragm
f - Pump Housing
g - Pump Housing Retaining Screws
h - Pump Check Valve - NOT REMOVABLE

Figure 8. Accelerator Pump Removed

5. Accelerator pump check balls are not removable. Check for clearance between ball and retainer. Check ball MUST be free to move as specified. (Figure 9)

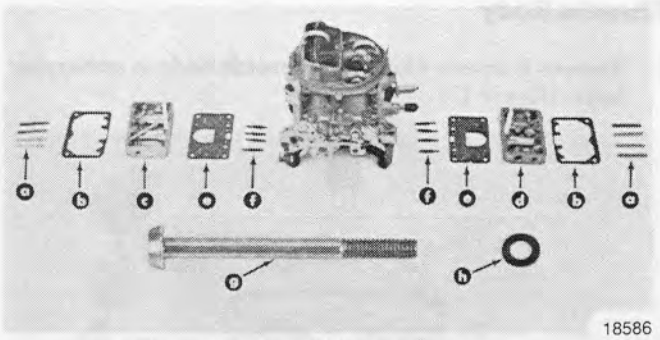


a - Retainer
b - Check Ball
c - Refer to "Specifications"

Figure 9. Accelerator Pump Check Ball

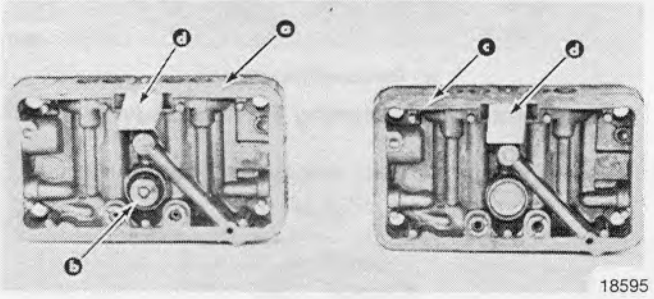
6. Remove attaching springs, studs, gaskets, primary, and secondary metering bodies from carburetor. (Figures 10 and 11)

IMPORTANT: Some model carburetors will have long thru-bolts instead of the attaching springs and studs.



a - Attaching Springs (475 Turbo Only)
b - Gaskets
c - Primary Metering Body
d - Secondary Metering Body
e - Gasket
f - Studs (475 Turbo Only)
g - Thru-Bolt Used on 440/460 Cyclone Engines.
h - Gasket

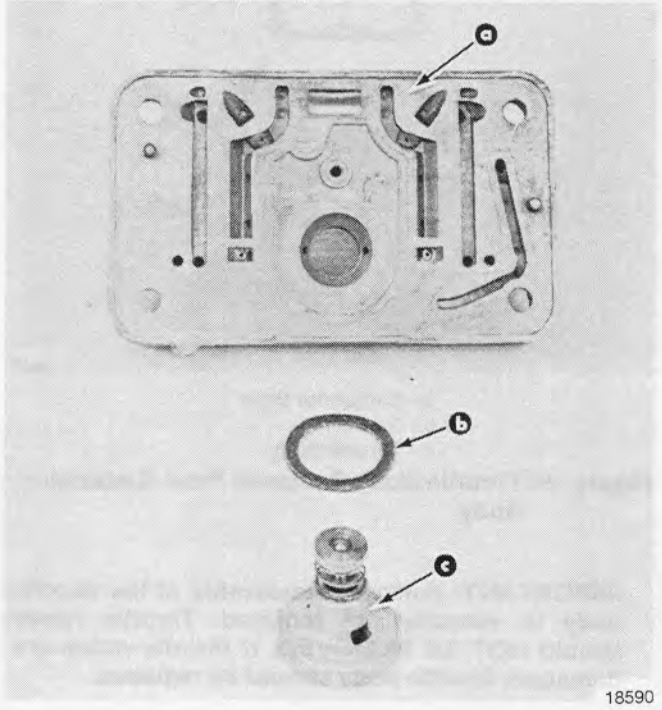
Figure 10. Removing Metering Bodies



a - Primary Metering Body
b - Power Valve
c - Secondary Metering Body (No Power Valve)
d - Float Bowl Vent Tubes

Figure 11. Metering Body Identification

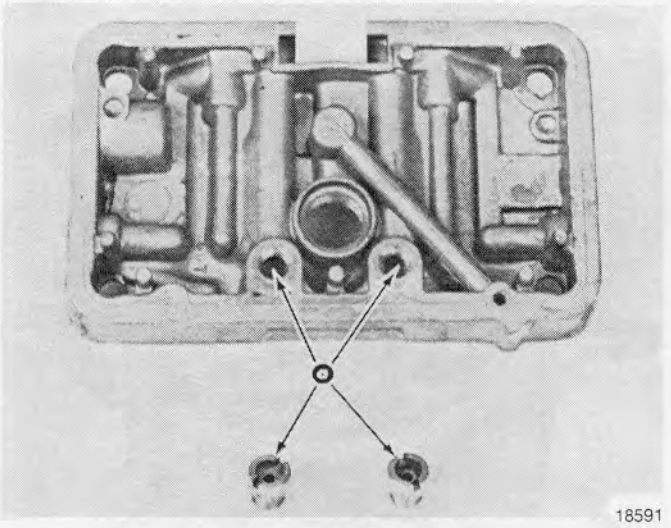
7. Remove power valve from primary metering body. Power valve cannot be serviced separately, if defective it must be replaced. (Figure 12)



a - Primary Metering Body
b - Gasket
c - Power Valve

Figure 12. Power Valve Removed

8. Remove main fuel jets from primary and secondary metering bodies. (Figure 13)

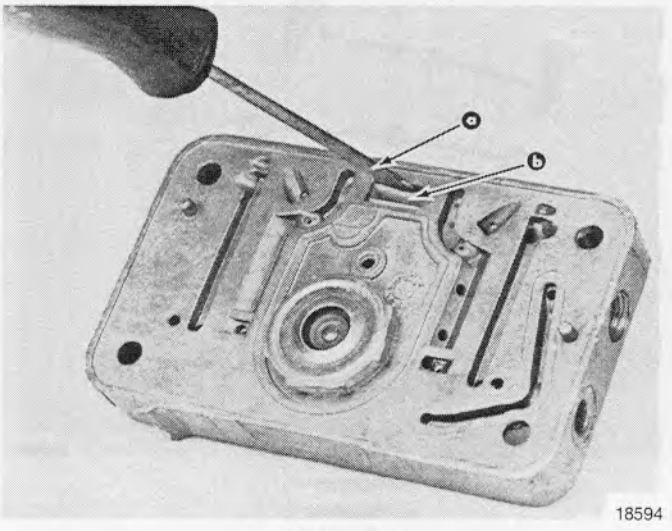


a - Main Fuel Jets

Figure 13. Main Fuel Jets Removed

9. Remove float bowls vent tubes. Pry down on top of vent tube with a small screwdriver and pull out. Vent tubes are held in place with small locating pin. (Figure 14)

IMPORTANT: Locating pins should NOT be removed from metering bodies.

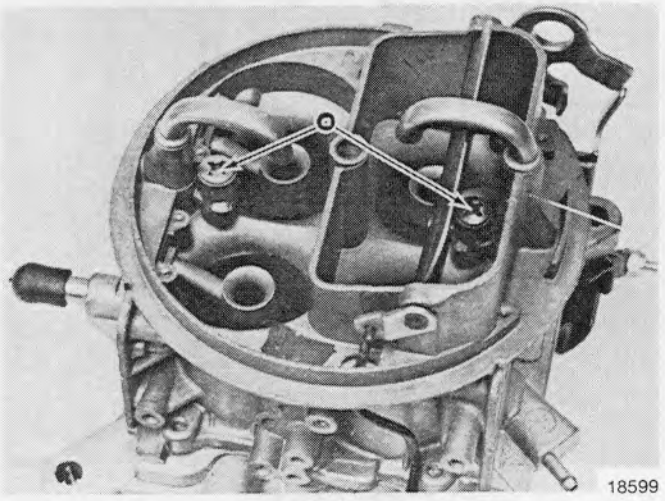


a - Small Screwdriver
b - Float Bowl Vent Tube

Figure 14. Removing Float Bowl Vent Tubes

Carburetor Body

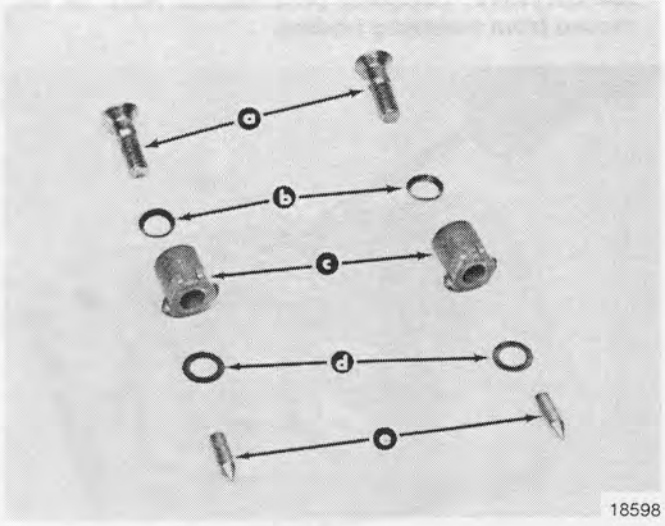
1. Remove 2 screws which hold accelerator pump discharge needles in place. (Figure 15)



a - Screws

Figure 15. Accelerator Pump Discharge Needle Retaining Screws.

2. Remove pump discharge needles and components. (Figure 16)



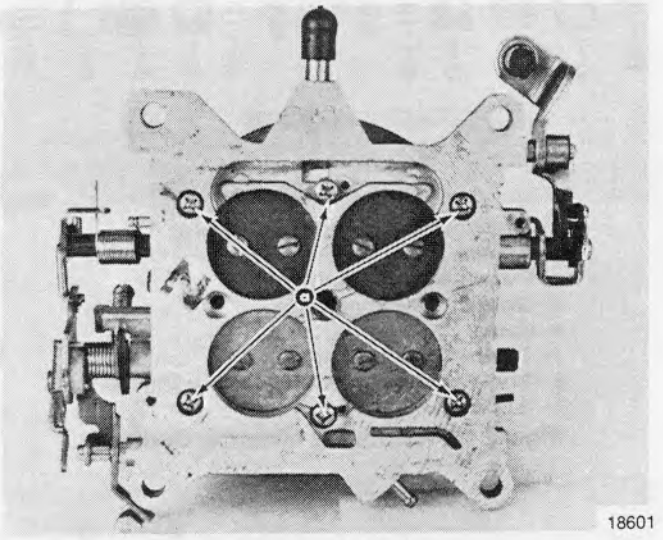
a - Screws
b - Gaskets
c - Bushings
d - Gaskets
e - Needles

Figure 16. Pump Discharge Needle Removed.

IMPORTANT: Choke valves should NOT BE REMOVED from carburetor body, if damaged, carburetor body should be replaced.

Throttle Body

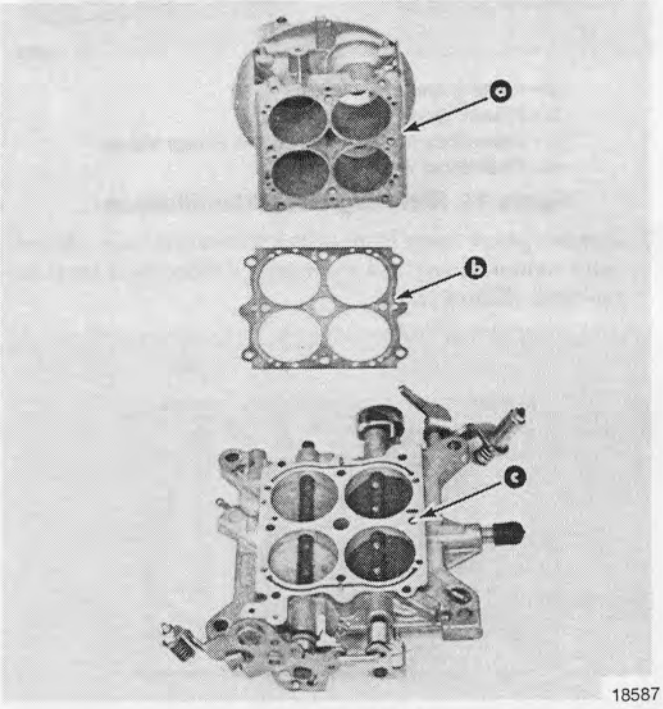
1. Remove 6 screws which hold throttle body to carburetor body. (Figure 17)



a - Remove 6 Screws

Figure 17. Removing Throttle Body

2. Remove carburetor body and gasket from throttle body. (Figure 18)



a - Carburetor Body
b - Gasket
c - Throttle Body

Figure 18. Throttle Body Removed From Carburetor Body

IMPORTANT: Further disassembly of the throttle body is normally not required. Throttle valves should NOT BE REMOVED. If throttle valves are damaged, throttle body should be replaced.

CLEANING and INSPECTION

Carbon, varnish, gum, dirt, and water contaminants in the carburetor or on exterior moving parts of the carburetor often are responsible for carburetion malfunctions. Therefore, carefully observe the following cleaning and inspection procedure, to obtain effective carburetor repair.

IMPORTANT: DO NOT use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and componenet replacement will be necessary.

⚠CAUTION

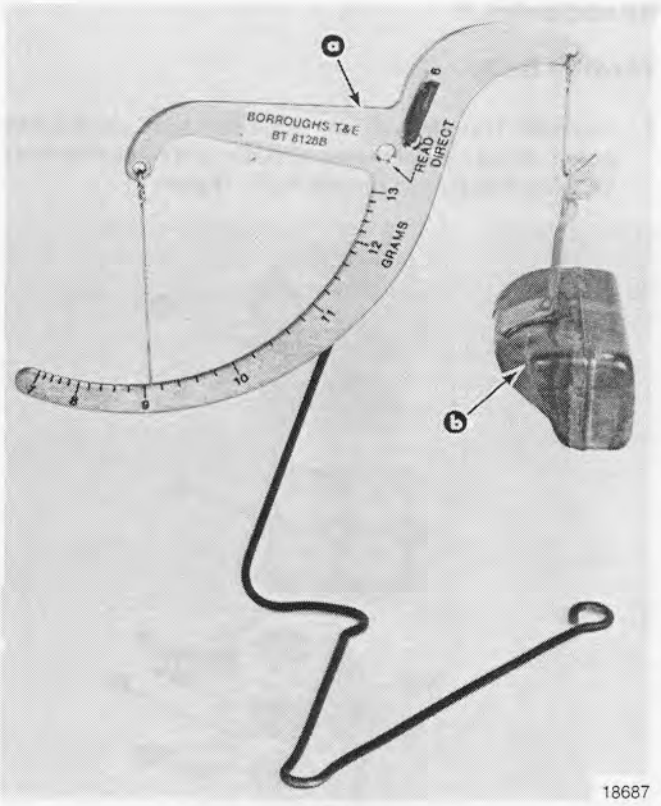
Any plastic, rubber, or neoprene parts SHOULD NOT be immersed in carburetor cleaner, as they will swell, harden, or distort.

IMPORTANT: All gaskets, "O" rings, and seals should be replaced during carburetor repair.

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe-off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:
   a. **Float Needle and Seat:** If float needle or seat is worn or damaged, replace with a new needle and seat assembly.

IMPORTANT: Float needle and seat are factory assembled. Needle and seat cannot be serviced separately.

   b. **Float Assembly and Hinge Pin:** Inspect float pontoon for deterioration and porosity. Check pontoon density (to see if it is saturated with fuel), by comparing weight of float with specifications. (Figure 1) If pontoon weight is high, float assembly MUST BE replaced. Shake float. If float contains fuel inside, float is leaking and must be replaced. Check hinge pin and holes for wear.
   c. **Fuel and Air Passages:** Passages MUST BE perfectly clean for proper carburetor operation.



a - Scale
b - Float

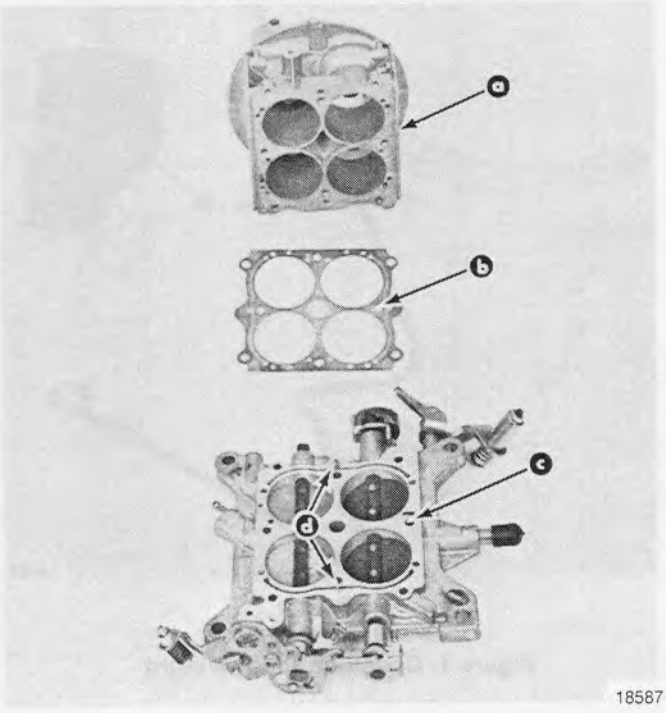
Figure 1. Checking Float Weight

   d. **Accelerator Pump Diaphragm and Return Spring:** Inspect pump diaphragm, check ball, discharge needles, and return spring.
   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.
   f. **Idle Mixture Needles:** Inspect idle mixture needles. If damaged, needles MUST BE replaced.
   g. **Levers and Linkages:** Check levers, links and rods for wear.
   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding thru entire operating range, making sure valve opens and closes completely. Throttle body assembly MUST BE replaced if throttle valve and shaft are worn or damaged.
   i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding thru entire operating range, making sure valve opens and closes completely. Carburetor body assembly MUST BE replaced if choke valve and shaft and lever assembly are worn or damaged.
   j. **Inspect casting** for visible damage. Inspect gasket surfaces.

REASSEMBLY

Throttle Body

1. Assemble throttle body to carburetor body using a new gasket, being careful to line up gasket and carburetor body with locating pins in throttle body. (Figure 1)



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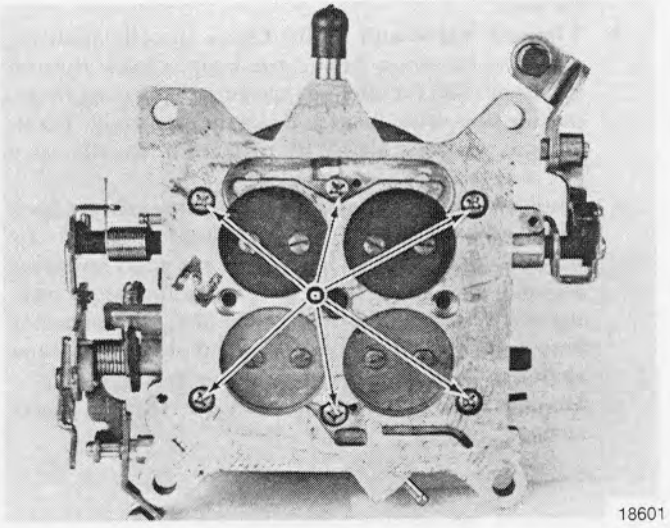
a - Carburetor Body
b - New Gasket
c - Throttle Body
d - Locating Pins

Figure 1. Installing Throttle Body

2. Install throttle body attaching screws and tighten evenly and securely. (Figure 2)



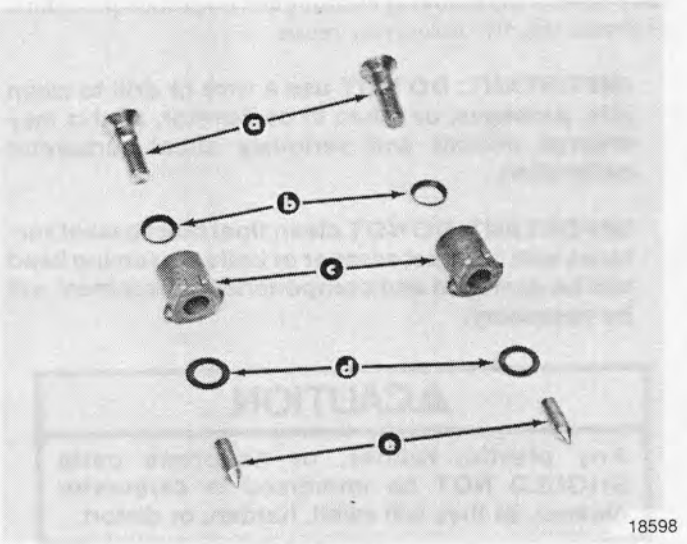
18601

a - 6 Attaching Screws

Figure 2. Installing Attaching Screws

Carburetor Body

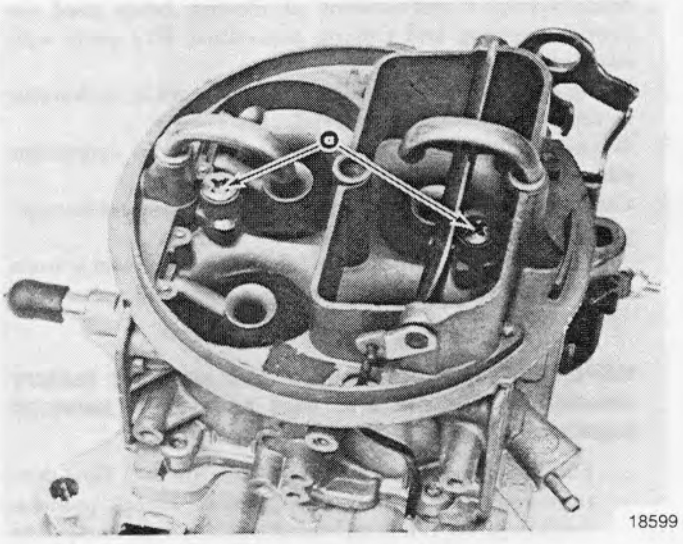
1. Install pump discharge needles into carburetor body in order shown in Figure 3. Tighten screws securely. (Figure 4)



18598

a - Screws
b - Gaskets
c - Bushings
d - Gaskets
e - Needles

Figure 3. Installing Pump Discharge Needles



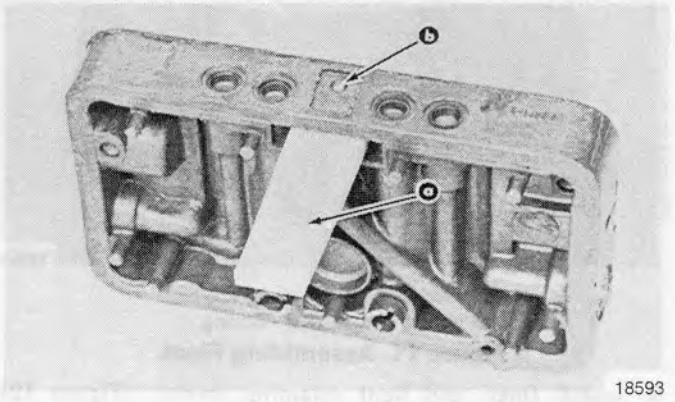
18599

a - Pump Discharge Needle Retaining Screws

Figure 4. Retaining Screws Installed

Fuel Bowls and Metering Bodies

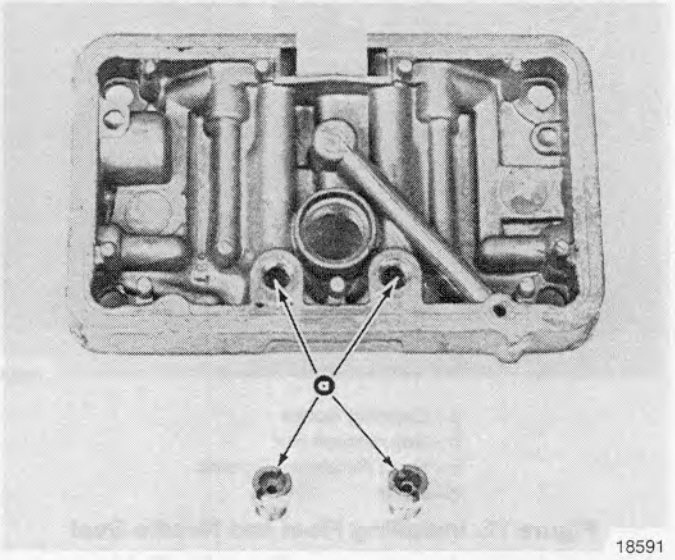
1. Install fuel bowl vent tubes into metering bodies, vent tube must be pushed in far enough to lock into locating pin. (Figure 5)



a - Vent Tube
b - Locating Pin

Figure 5. Installing Vent Tubes

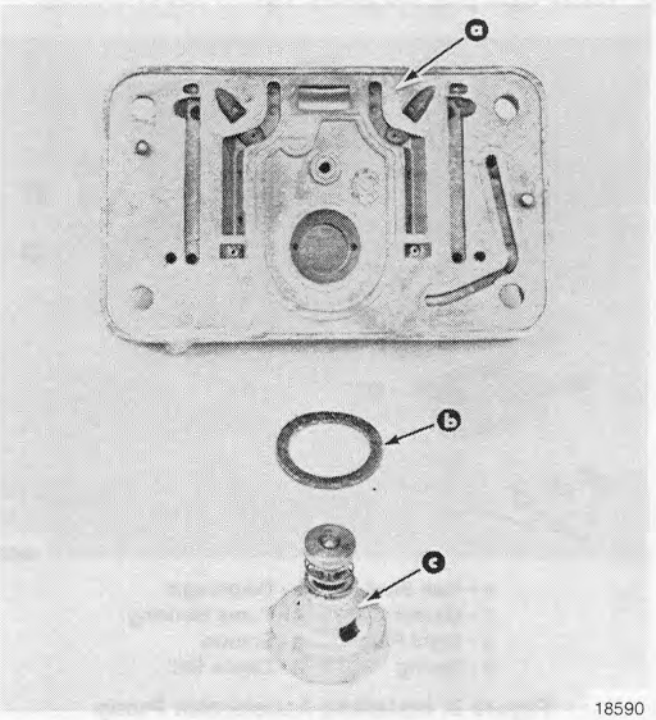
2. Install primary and secondary main fuel jets. (Figure 6)



a - Main Fuel Jets

Figure 6. Installing Main Fuel Jets

3. Install power valve and new gasket in primary metering body.

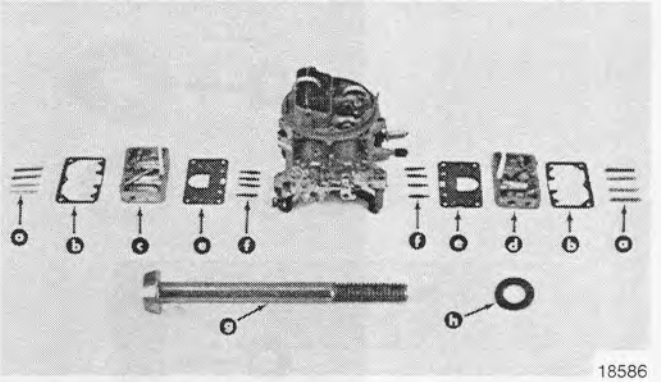


a - Primary Metering Body
b - Gasket
c - Power Valve

Figure 7. Installing Power Valve

4. Assemble metering bodies to carburetor body in order shown in Figure 8.

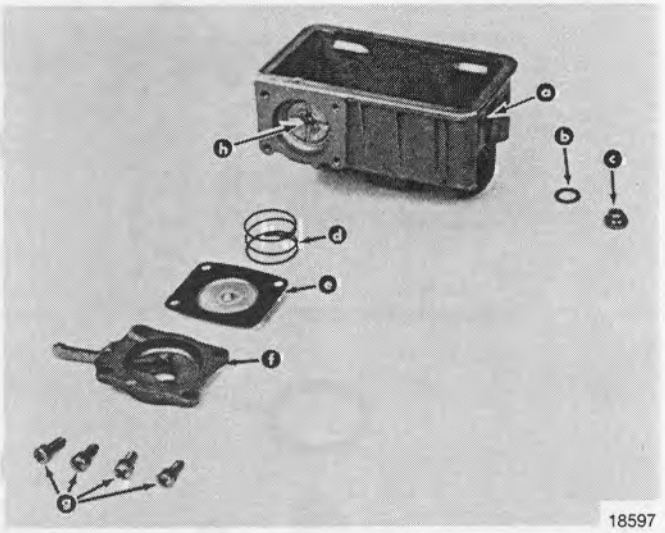
IMPORTANT: On 440/460 Cyclone carburetors this operation cannot be performed until fuel bowls are assembled because the carburetor has through bolts in place of the springs.



a - Springs (475 Turbo Only)
b - Gasket
c - Primary Metering Body
d - Secondary Metering Body
e - Gasket
f - Studs (475 Turbo Only)
g - Thru-Bolts (440/460 Cyclone)
h - Gasket

Figure 8. Installing Metering Bodies

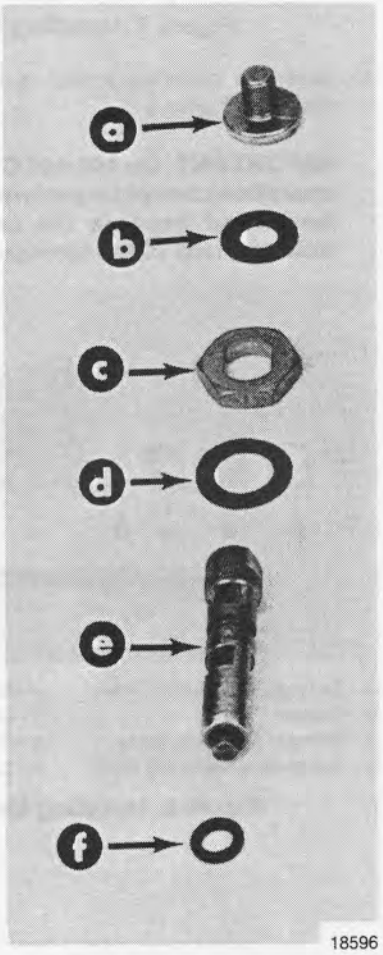
5. Install accelerator pump assembly as shown in Figure 9.
6. Install sight plug and gasket. Tighten screws securely.



a - Fuel Bowl
b - Gasket
c - Sight Plug
d - Spring
e - Diaphragm
f - Pump Housing
g - Screws
h - Check Ball

Figure 9. Installing Accelerator Pump

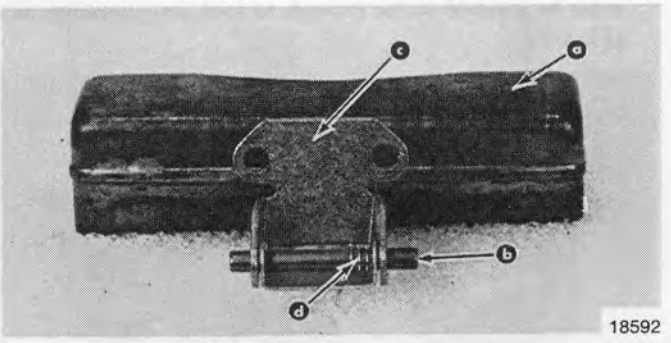
7. Assemble needle seat as shown in Figure 10.



a - Locking Screw
b - Gasket
c - Adjustment Nut
d - Gasket
e - Needle Seat Assembly
f - "O" Ring

Figure 10. Needle Seat Assembly

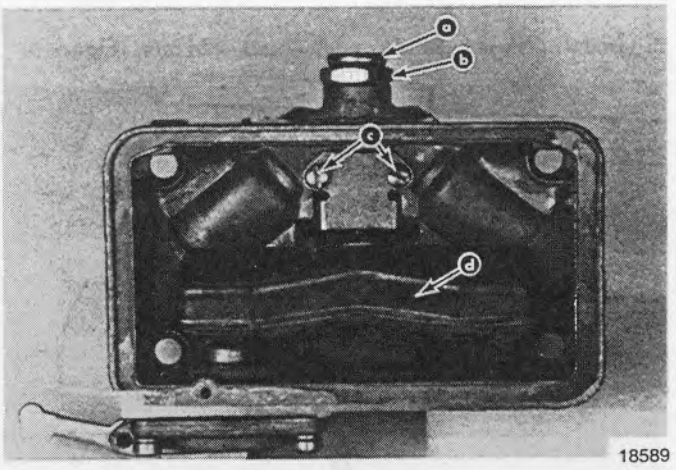
8. Assemble float, spring, hinge, and hinge pin as shown in Figure 11.



a - Float
b - Hinge Pin
c - Hinge
d - Spring

Figure 11. Assembling Float

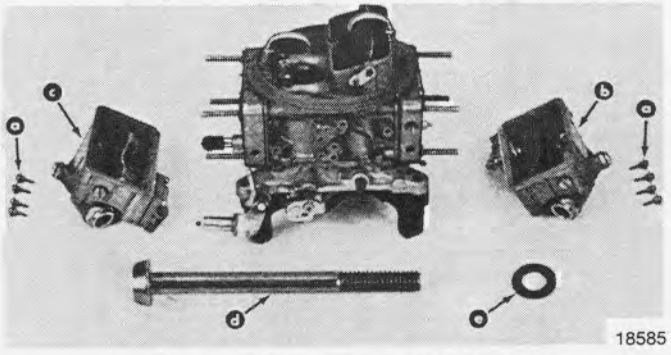
9. Install float, and float retaining screws. (Figure 12) Tighten screws securely. Install needle seat assembly. Adjust float to specifications. See "Adjustments" in this section.



a - Locking Screw
b - Adjustment Nut
c - Float Retaining Screws
d - Float

Figure 12. Installing Float and Needle Seat

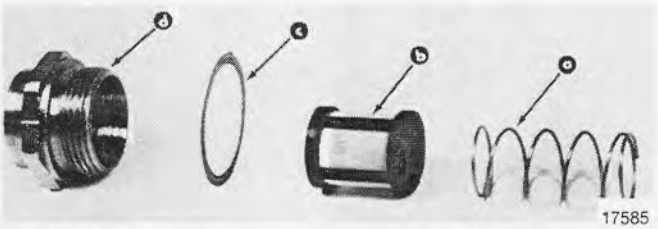
10. Install fuel bowls as shown in Figure 13. Tighten screws securely.



a - Screw and Gaskets (Gaskets Not Shown)
b - Primary Fuel Bowl
c - Secondary Fuel Bowl
d - Thru-Bolts (440/460 Cyclone)
e - Gasket

Figure 13. Installing Fuel Bowls

11. Install fuel inlet filter components, fuel inlet gasket, and nut as shown in Figure 14. Tighten nut securely.

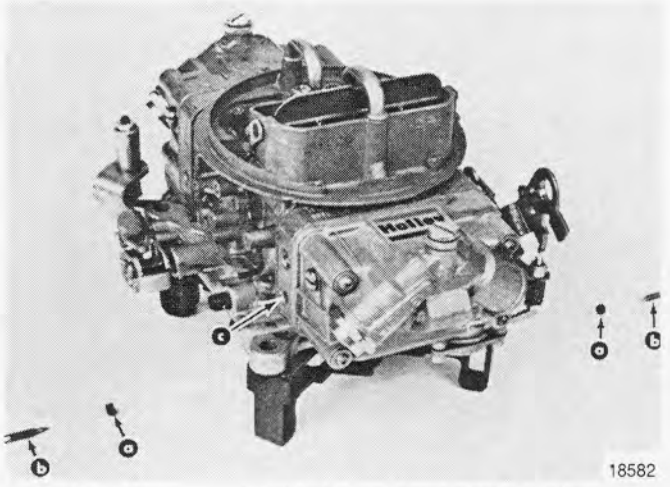


a - Spring
b - Filter (Open End Towards Nut)
c - Gasket
d - Fuel Inlet Nut

Figure 14. Installing Filter and Inlet Nut

12. Install idle mixture screws and gaskets. Lightly seat needle, then back out 2 turns. (Figure 15)

IMPORTANT: Do not tighten idle mixture needles against seats or damage to needle and/or seat may result.

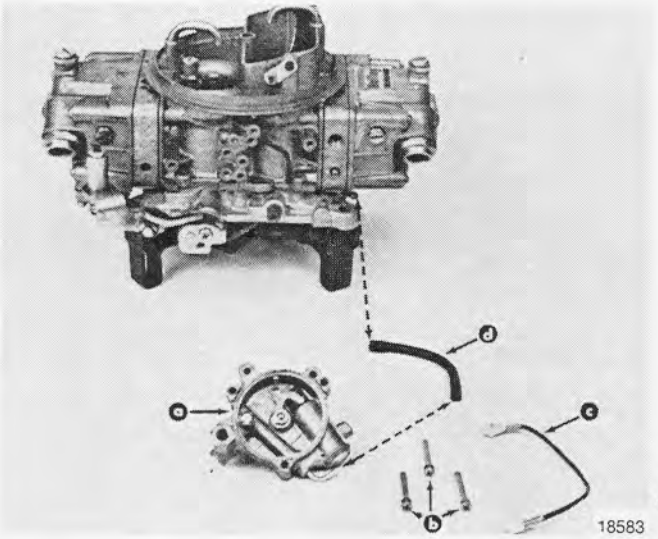


a - Gaskets
b - Needles
c - Idle Mixture Hole (Only One Shown)

Figure 15. Installing Idle Mixture Screws

Choke Housing

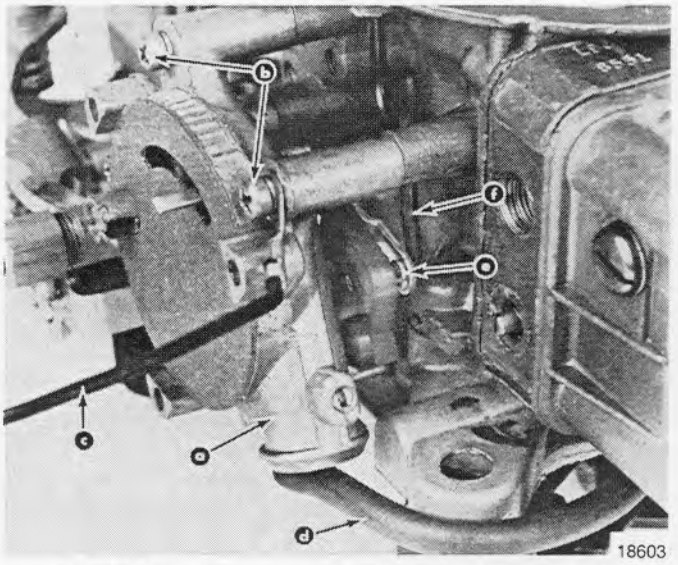
1. Install choke housing as shown in Figures 16 and 17. Tighten screws securley.



a - Choke Housing
b - Screws
c - Ground Wire
d - Vacuum Hose

Figure 16. Installing Choke Housing

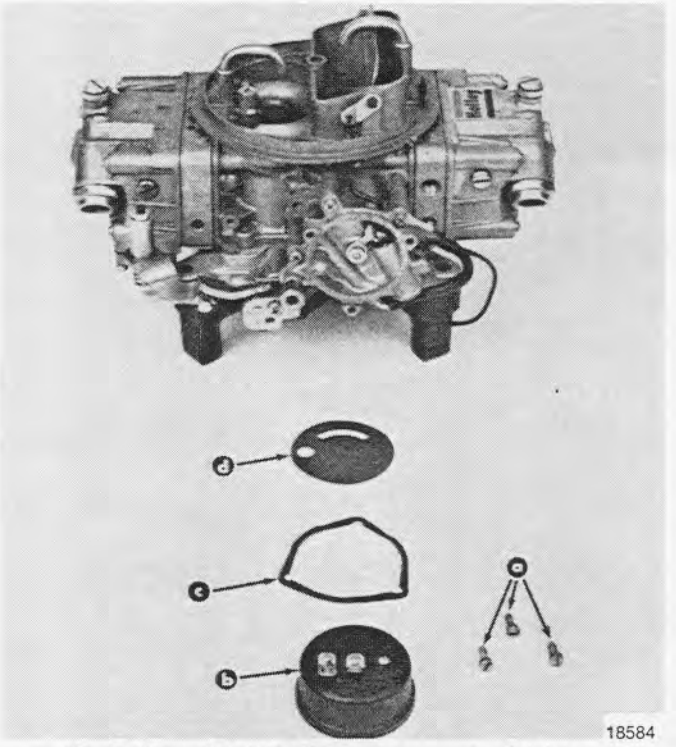
2. Install choke rod retaining clip.



a - Choke Housing
b - Screws
c - Ground Wire
d - Vacuum Hose
e - Choke Rod Retaining Clip
f - Choke Rod

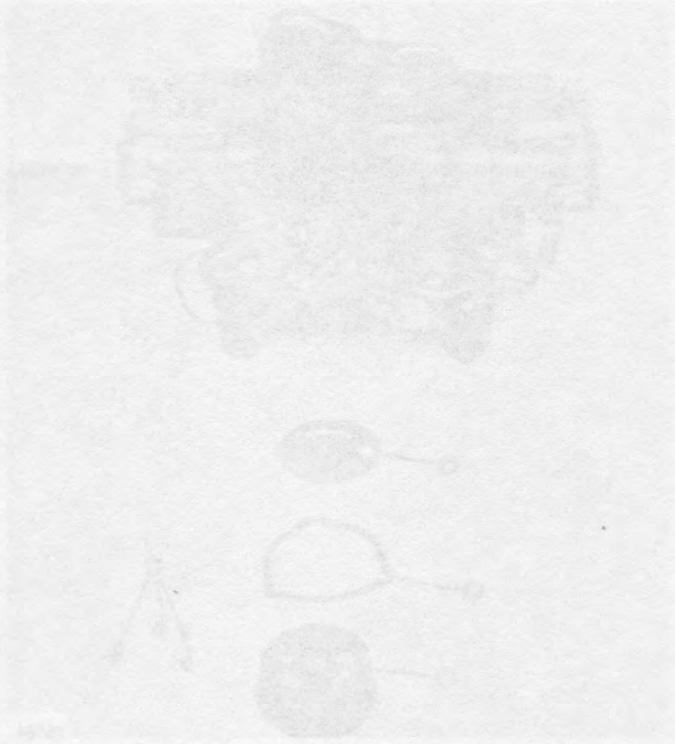
Figure 17. Retaining Clip Installed

3. Install choke cover as shown in Figure 18. Adjust choke to "Specifications". Tighten screws securely. Be sure to hook choke heat element into choke lever.



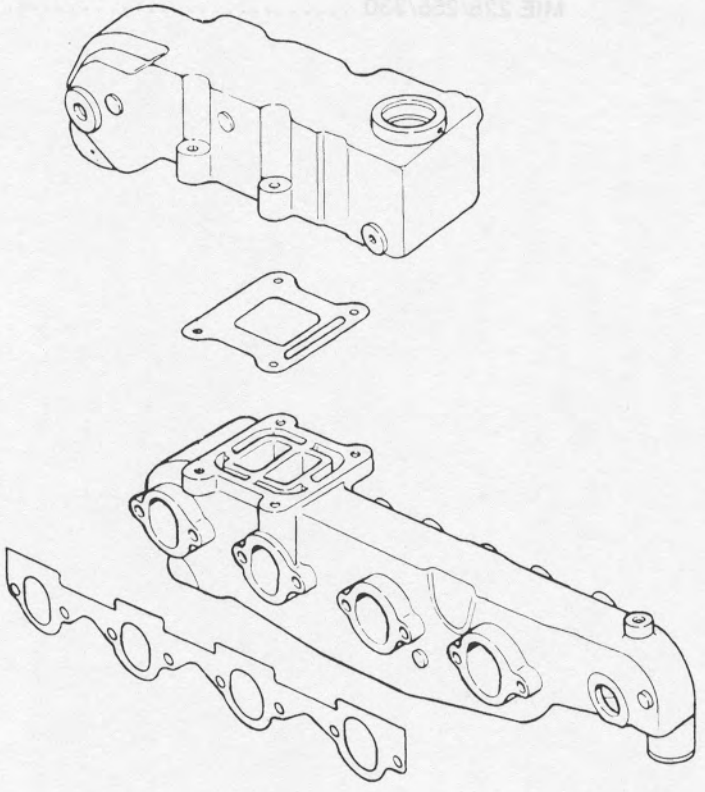
a - Choke Cover Retaining Screws
b - Choke Cover
c - Retainer
d - Gasket

Figure 18. Installing Choke Cover



SECTION 5 - EXHAUST SYSTEM

PART A - EXHAUST MANIFOLDS/ELBOWS



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STERN DRIVES & INBOARDS

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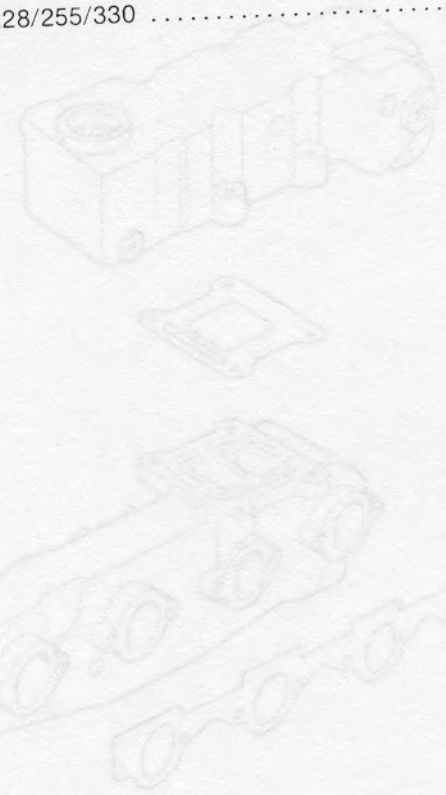


TORQUE SPECIFICATIONS

MCM 120/140/165		
Fastener Location	**Lbs. Ft. (N.m)**	**Lbs. In. (N.m)**
Battery Cables	Securely	
Carburetor	20 (27)	
Hose Clamps	Securely	
End Cap		96 (11)
Exhaust Elbow	25 (34)	
Exhaust Manifold (Note 1)	23 (33)	
Intake Manifold Cover	15 (20)	

NOTE 1: Retorque after engine has been brought up to operating temperature.

MCM/MIE 470		
Fastener Location	**Lbs. Ft. (N.m)**	**Lbs. In. (N.m)**
Battery Cables	Securely	
Hose Clamps	Securely	
End Cap		96 (11)
Exhaust Elbow	25 (34)	
Exhaust Manifold	25 (34)	
Reservoir	20 (27)	
Thermostat/Distribution Housing	20 (27)	

MCM 470R/485/488R		
Fastener Location	**Lbs. Ft. (N.m)**	**Lbs. In. (N.m)**
Battery Cables	Securely	
Hose Clamps	Securely	
Exhaust Elbow/Reservoir	30 (41)	
Exhaust Manifold	25 (34)	
Thermostat Housing	20 (27)	

MCM 898/228/260/330/370/400/400 Cyclone/475 Turbo MIE 228/230/255/260/330/340		
Fastener Location	**Lbs. Ft. (N.m)**	**Lbs. In. (N.m)**
Battery Cables	Securely	
Hose Clamps	Securely	
Distribution Block	25 (34)	
End Cap		96 (11)
Exhaust Elbow	25 (34)	
Exhaust Manifold (Note 1)	25 (34)	

NOTE 1: MCM 370/400/400 Cyclone/475 Turbo - 35 lbs. ft. (48 N.m) on bolts, 25 lbs. ft. (34 N.m) on nuts.

SEALANTS

SEALANTS	
92-32609-1	Quicksilver Loctite
92-34227--1	Quicksilver Perfect Seal

CLEANING and INSPECTION

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
3. Check water passages for foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Perfect Seal before reinstalling.

5. Check for cracks.
6. To test manifold body for leaks, block off plates, plugs, or short hoses with plugged ends must be used. One block off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block off plate(s). Apply 40 PSI (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.

MCM 470R/485/488R: Using new gaskets, install elbow/reservoir assembly to manifold body. Using hoses, plugs and clamps, seal all openings that coolant would flow thru (seawater inlet and outlet do not have to be plugged). Pressure check the assembly, using automotive radiator tester. Follow tool manufacturer's instructions.

REMOVAL

1. Disconnect battery cables from battery.
2. Drain water from cylinder block, exhaust manifold and exhaust elbow.
3. Disconnect throttle cable at carburetor.
   MCM 120R/140R: Remove both shift cables from shift plate assmebly.
4. Disconnect exhaust hose and cooling hoses.
5. Disconnect fuel line at carburetor.
6. Disconnect crankcase ventilation hose at rocker arm cover.
7. Remove wiring harness clamps and slave solenoid from manifold.
   MCM 120R/140R: Disconnect engine harness shift cut-out switch wires and wires going to electric choke.
8. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
9. Remove exhaust elbow.
   MCM 120R/140R: Remove exhaust adaptor.
10. Refer to "Cleaning and Inspection".

IMPORTANT: MCM 120: If manifold to cylinder head studs have broken, install all new studs with Loctite "A" after checking head and manifold surfaces for warpage. Also use all new manifold attaching nuts.

INSTALLATION

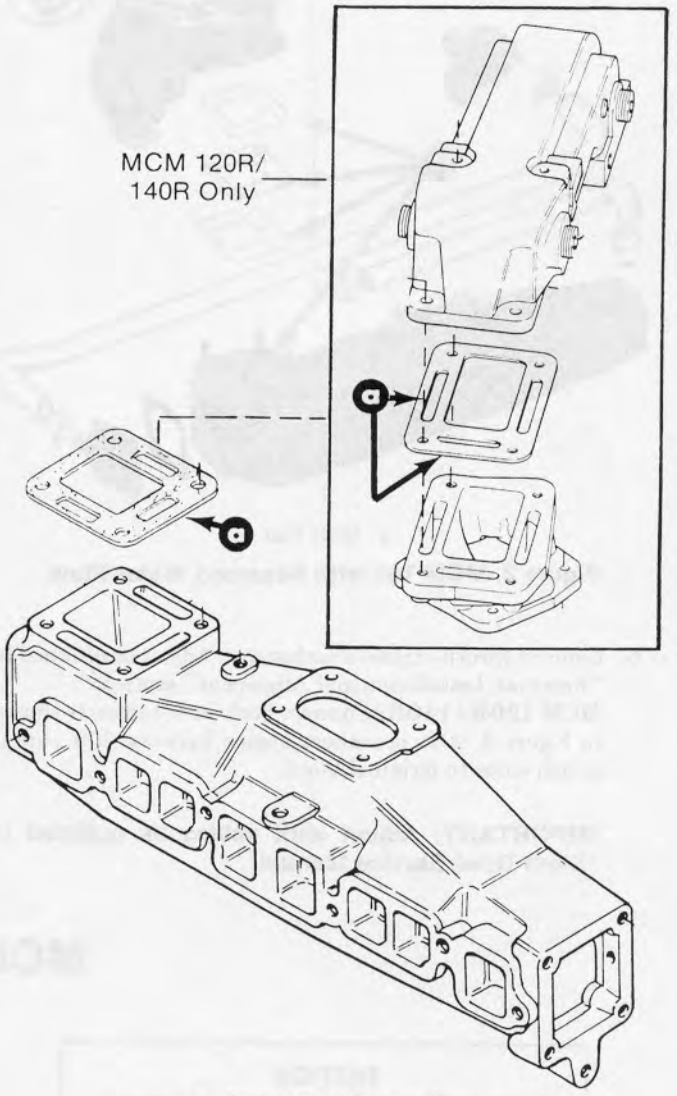
If exhaust manifold body requires replacement, transfer all parts (from old manifold) to new manifold body.

1. Position new gasket on head and install manifold in position, making sure gasket is in place.
2. Tighten fasteners evenly and torque to specifications, starting in center and working out toward ends.

IMPORTANT: After engine has been brought up to operating temperature, allow engine to cool. Re-torque manifold fasteners.

3. Install carburetor (if removed) and connect crankcase ventilation hose at rocker arm cover.
4. Install wiring harness clamps and slave solenoid to manifold.
5. Install exhaust elbow using new gasket. (Figure 1 or 2) Torque to specifications.
   MCM 120R/140/140R/165: Gaskets must be installed as shown in Figure 1.

IMPORTANT: If engine is equipped with a 3" or 6" riser, refer to "Section 5, Part B".



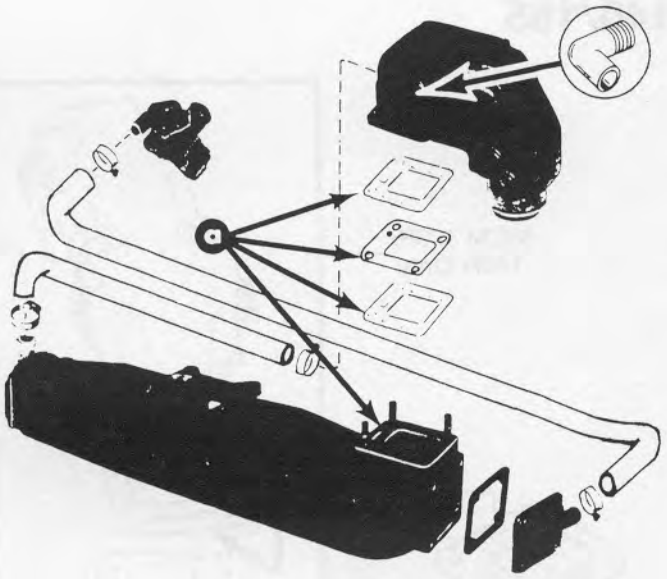
a - Gasket (Stot Forward)

Figure 1. Gasket Installation

MCM 165 with Reversed Water Flow:

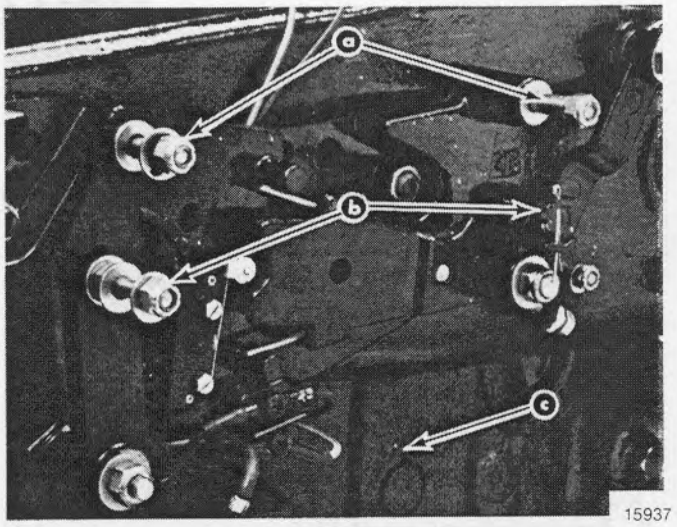
IMPORTANT: Be certain that the wide part of gasket/plate is positioned toward front of engine.

a. Coat both sides of gaskets with Perfect Seal.
b. Install kit as shown in Figure 2. Be sure to perform the following:
   - Torque exhaust elbow nuts to specifications.
   - Tighten end cap screws securely.
   - Tighten all hose clamps securely.



a - Wide Part

Figure 2. MCM 165 with Reversed Water Flow



a - Remote Control Shift Cable Attaching Points
b - Drive Unit Shift Cable Attaching Points
c - Exhaust Manifold

Figure 3. MCM 120R/140R

6. Connect throttle cable to carburetor. Adjust as outlined in "Removal, Installation and Alignment" section.
   MCM 120R/140R: Connect both shift cables as shown in Figure 3. Also reconnect engine harness shift cutout switch wires to terminal block.

   IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".

7. Connect fuel line and choke tube or electric choke wires.
8. Reinstall exhaust and cooling hoses.
9. Reconnect battery cables to battery. Tighten securely.
10. Start engine, check for exhaust, water and fuel leaks and adjust carburetor idle speed and mixture.

MCM/MIE 470

NOTICE
Refer to Figure 1 for parts breakdown.

REMOVAL

1. Disconnect battery cables from battery.
2. Drain engine coolant and seawater.
3. Disconnect wire from temperature sending unit.
4. Disconnect all water and exhaust hoses from manifold assembly.

   NOTE: You may have to drain engine oil and remove dipstick tube to remove manifold.

5. Remove wiring harness clamps and starter solenoid from manifold.
6. Remove exhaust manifold fasteners. Remove manifold assembly and discard gasket.

DISASSEMBLY

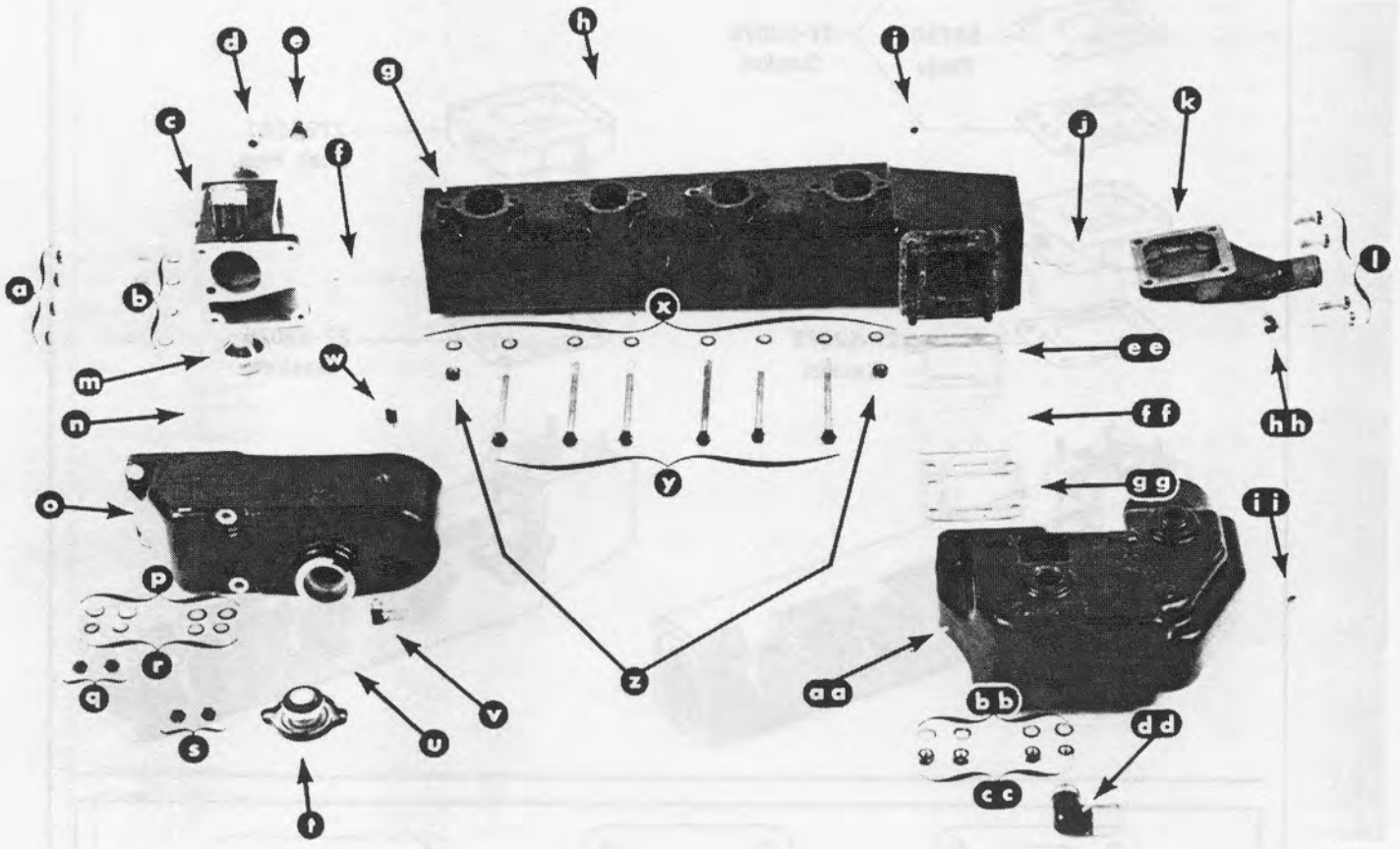
1. Remove coolant reservoir from thermostat/distribution housing and remove thermostat.
2. Remove thermostat/distribution housing from manifold body.
3. Remove temperature sender and brass plug from thermostat/distribution housing.
4. Remove exhaust elbow from manifold body.
5. Remove end cap from aft end of manifold body.
6. Refer to "Cleaning and Inspection".

REASSEMBLY

1. Install new gasket and end cap on aft end of manifold body (with hose connector facing toward engine sides of manifold). Torque to specifications.
2. Place new gasket, plate, second gasket and exhaust elbow onto manifold body, as shown in Figure 1 for MCM models and Figure 2 for MIE models. Install lockwasher and nuts. Torque to specifications.

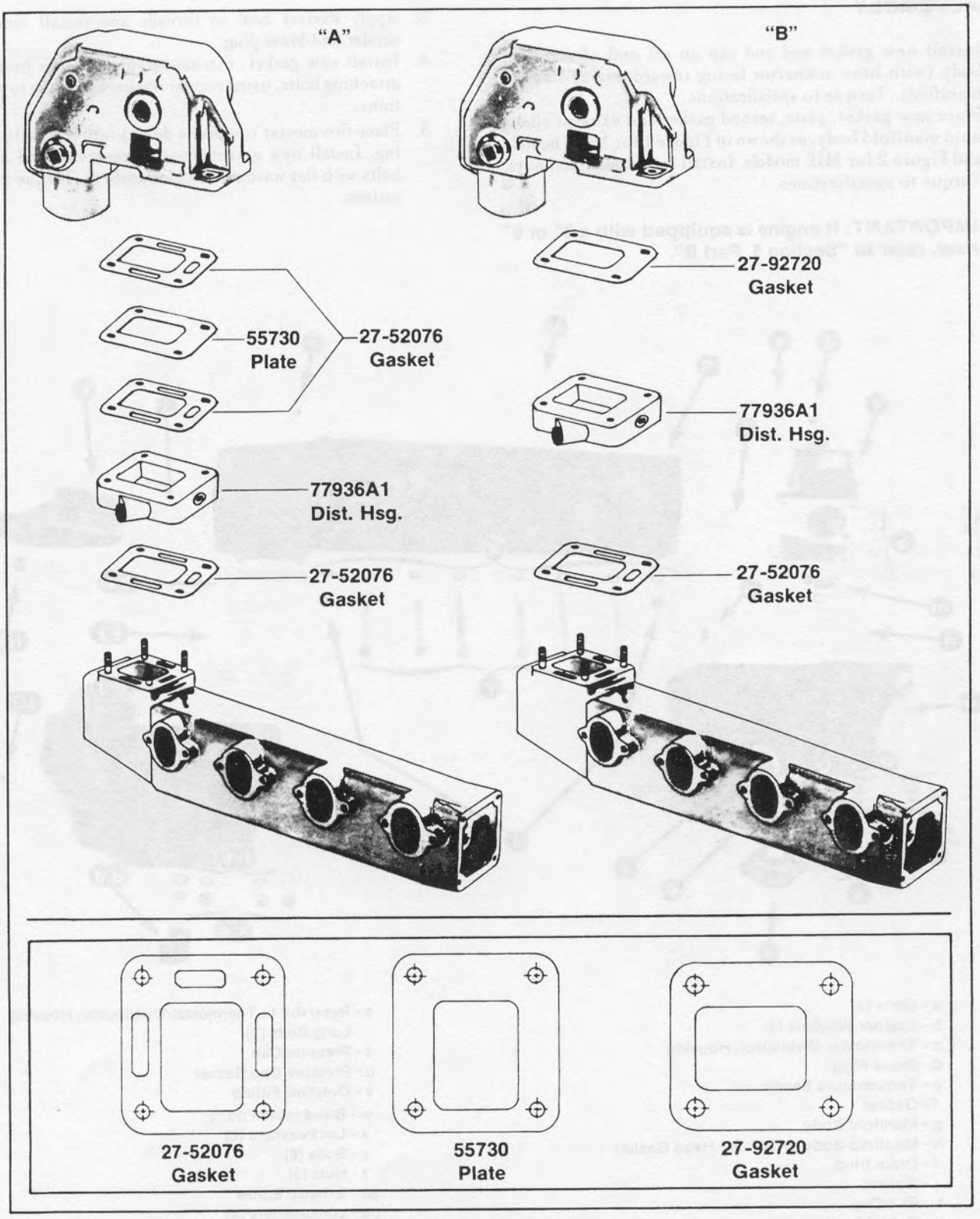
IMPORTANT: If engine is equipped with a 3" or 6" riser, refer to "Section 5, Part B".

3. Apply Perfect Seal to threads and install temperature sender and brass plug.
4. Install new gasket, thermostat/distribution housing and attaching bolts, using copper washers. Torque to specifications.
5. Place thermostat (umbrella down) into its cavity in housing. Install new gasket, coolant reservoir and attaching bolts with flat washers and lockwashers. Torque to specifications.



a - Bolts (4)
b - Copper Washers (4)
c - Thermostat-Distribution Housing
d - Brass Plug
e - Temperature Sender
f - Gasket
g - Manifold Body
h - Manifold Body to Cylinder Head Gasket
i - Drain Plug
j - Gasket
k - End Cap
l - Bolts (4)
m - Thermostat
n - Gasket
o - Coolant Reservoir
p - Flat Washers (4)
q - Reservoir to Thermostat/Distribution Housing Short Bolts (2)
r - Lockwashers (4)
s - Reservoir to Thermostat/Distribution Housing Long Bolts (2)
t - Pressure Cap
u - Pressure Cap Gasket
v - Overflow Fitting
w - Bleed Hose Fitting
x - Lockwashers (8)
y - Bolts (6)
z - Nuts (2)
aa - Exhaust Elbow
bb - Lockwashers (4)
cc - Nuts (4)
dd - Hose Connector Elbow
ee - Gasket
ff - Plate
gg - Gasket
hh - Bleed Hose Fitting
ii - Drain Plug

Figure 1. MCM/MIE 470



a - 77936A1 Aluminum Casting
b - 77936A1 Cast Iron Casting

Figure 2. MIE 470 Engines

INSTALLATION

1. Using a new gasket, position manifold assembly onto cylinder head and install lockwashers, nuts and bolts. Torque to specifications.

   NOTE: If removed, install dipstick tube to oil pan and to support clamp located on exhaust manifold fastener bolt. Fill engine to proper oil level.

2. Connect all water and exhaust hoses to manifold assembly. Tighten hose clamps securely.
3. Connect engine harness wire to temperature sender.
4. Install wiring harness clamps and starter solenoid.
5. Fill closed cooling system to proper coolant level.
6. Pressure check the cooling system, using automotive radiator tester. Follow tool manufacturer's instructions.
7. Reconnect battery cables to battery. Tighten securely.
8. Start engine and check for leaks.

MCM 470R/485/488R

REMOVAL

1. Disconnect battery cables from battery.
2. Drain engine coolant and seawater.
3. Disconnect wire from temperature sending unit.
4. Disconnect all hoses and exhaust bellows from manifold assembly.

   NOTE: You may have to drain engine oil and remove dipstick tube to remove manifold.

5. Remove wiring harness clamps from manifold.
6. **MCM 470R/488R:** Remove both shift cables from shift plate assembly.
7. **MCM 470R/488R:** Disconnect engine harness shift cut-out switch wires.
8. Remove exhaust manifold fasteners. Remove manifold assembly and discard gasket.

DISASSEMBLY

NOTICE
To test manifold and reservoir for leaks, refer to "Cleaning and Inspection" before disassembly.

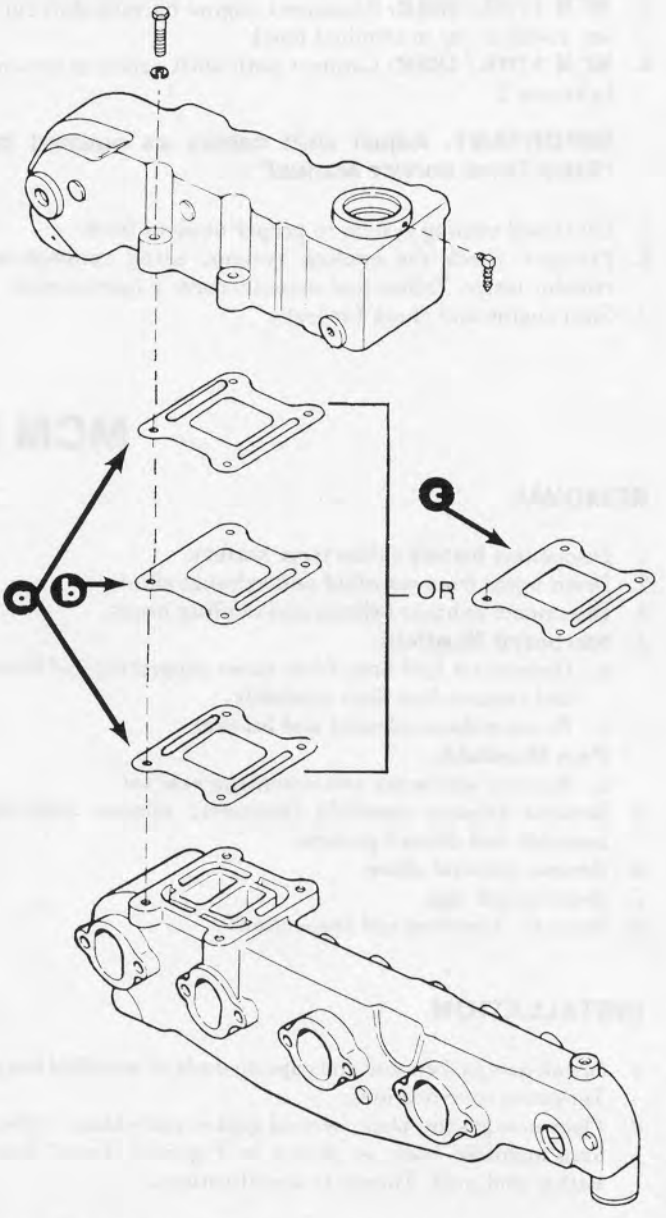
1. Remove exhaust elbow/reservoir assembly.
2. Remove thermostat housing and thermostat.
3. Remove temperature sender and brass plug.
4. Refer to "Cleaning and Inspection".

REASSEMBLY

1. If manifold body requires replacement, transfer parts from old body.
2. If exhaust elbow/reservoir requires replacement, transfer parts from old assembly.
3. Using new gaskets, install exhaust elbow/reservoir assembly to manifold. Torque to specifications.

   IMPORTANT: Gaskets and plate must be installed as shown in Figure 1 or leak will occur.

4. Using Perfect Seal on threads, install temperature sender and brass plug.
5. Using new gasket, install thermostat and thermostat housing. Torque to specifications.



a - Gasket
b - Stainless Steel Plate (Slot Forward)
c - 27-97542 Separator Gasket (Slot Forward)

Figure 1. Plate or Gasket Installation

INSTALLATION

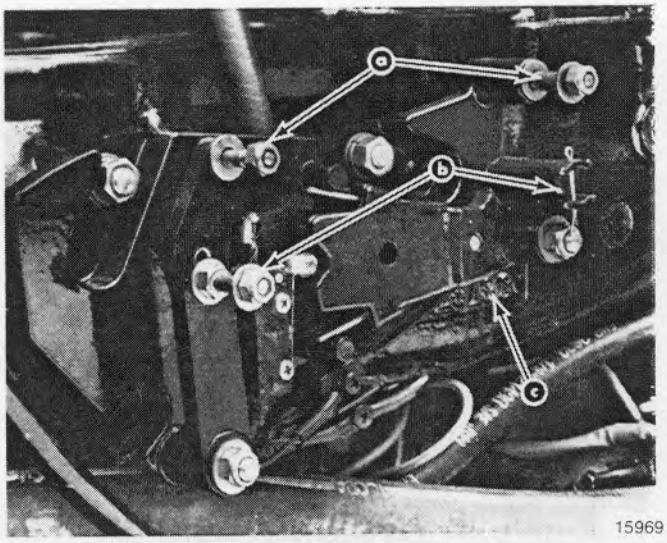
1. Using a new gasket, position manifold assembly onto cylinder head and install lockwashers, nuts and bolts. Torque to specifications.

   NOTE: If removed, install dipstick tube to oil pan and to support clamp located on exhaust manifold fastener bolt. Fill engine to proper oil level.

2. Connect all hoses and exhaust bellows to manifold assembly. Tighten clamps securely.
3. Connect engine harness wire to temperature sender.
4. Install wiring harness clamps.
5. **MCM 470R/488R:** Reconnect engine harness shift cut-out switch wires to terminal block.
6. **MCM 470R/488R:** Connect both shift cables as shown in Figure 2.

   IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".

7. Fill closed cooling system to proper coolant level.
8. Pressure check the cooling system, using automotive radiator tester. Follow tool manufacturer's instructions.
9. Start engine and check for leaks.



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a - Remote Control Shift Cable Attaching Points
b - Drive Unit Shift Cable Attaching Points
c - Exhaust Manifold

Figure 2. MCM 470R/488R

MCM 898/228/260

REMOVAL

1. Disconnect battery cables from battery.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust bellows and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect fuel lines from water separating fuel filter and remove fuel filter assembly.
   b. Remove slave solenoid and bracket.

   Port Manifold:
   a. Remove alternator and mounting bracket.
5. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
6. Remove exhaust elbow.
7. Remove end caps.
8. Refer to "Cleaning and Inspection".

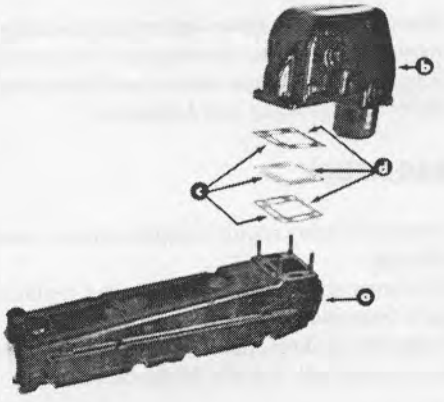
INSTALLATION

1. Install new gaskets and end caps on ends of manifold body. Torque to specifications.
2. Place new gasket, plate, second gasket and exhaust elbow onto manifold body, as shown in Figure 1. Install lockwasher and nuts. Torque to specifications.

   IMPORTANT: If engine is equipped with a 3" or 6" riser, refer to "Section 5, Part B". If engine is equipped with a closed cooling system, refer to Figure 2.

3. Using new gasket, install manifold. Torque to specifications.
4. **Starboard Manifold:**
   a. Install water separating fuel filter. Connect fuel lines and tighten securely.
   b. Install slave solenoid and bracket. Tighten fasteners securely.

   Port Manifold:
   a. Install alternator bracket. Tighten bolts securely.
   b. Install alternator and adjust belt tension. Tighten all fasteners securely.



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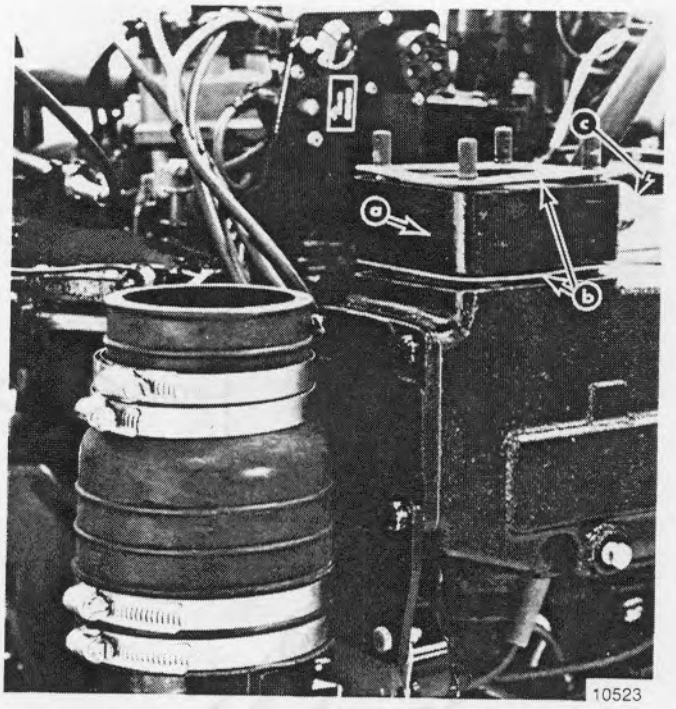
a - Exhaust Manifold
b - Exhaust Elbow
c - Wide Part of Gaskets/Plate (Vent Hole Forward) and Manifold/Elbow
d - Narrow Part of Gaskets/Plate and Manifold/Elbow

Figure 1. Without Closed Cooling

5. Reconnect exhaust bellows and water hoses. Tighten clamps securely.
6. Reconnect battery cables to battery. Tighten securely.
7. Start engine and check for fuel, exhaust and water leaks.



a - Distribution Block (Water Passages Toward Manifold)
b - Wide Part of Gasket Forward
c - Hose Fitting Forward

Figure 2. With Closed Cooling

MCM 898R/228R/260R

REMOVAL

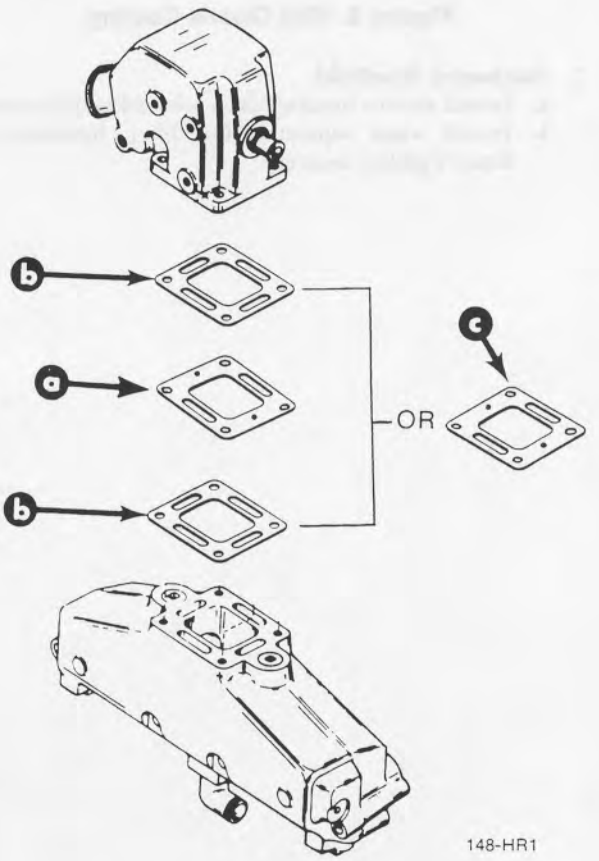
IMPORTANT: If engine is equipped with a 3" or 6" riser, refer to "Section 5, Part B". If engine is equipped with a closed cooling system, refer to Figure 2.

1. Disconnect battery cables from battery.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust bellows and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect both shift cables.
   b. Disconnect instrument harness plug from engine harness. Remove shift plate assembly from exhaust elbow.
   c. Disconnect fuel lines and remove filter assembly.
   d. Remove circuit breaker/slave solenoid and bracket.

   Port Manifold:
   a. Remove ignition amplifier from exhaust elbow.
5. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
6. Remove exhaust elbow.
7. Refer to "Cleaning and Inspection".

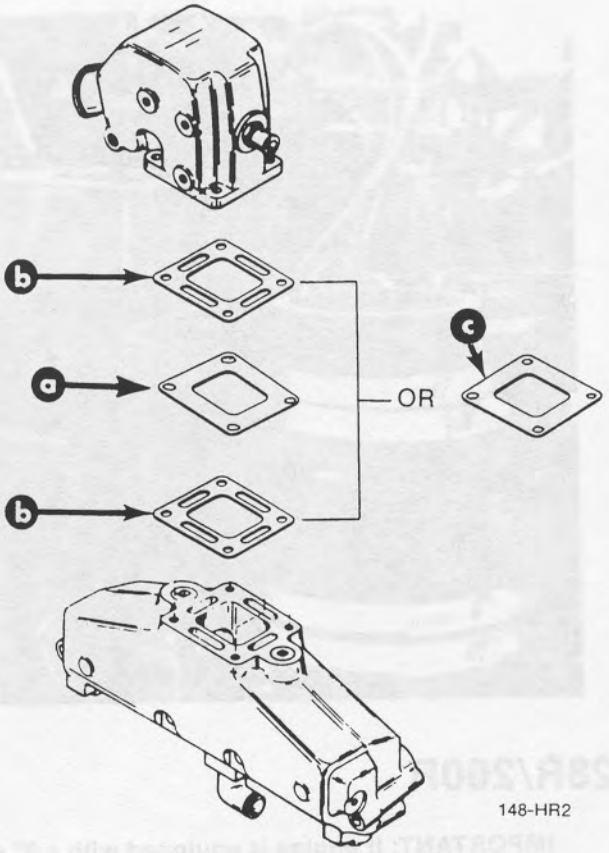
INSTALLATION

1. Using new gasket, install exhaust manifold to cylinder head. Torque to specifications.
2. Install exhaust elbow as shown in Figure 1. Torque to specifications.



a - Stainless Steel Restrictor Plate
b - Gaskets
c - 27-41813 Restrictor Gasket

Figure 1. Without Closed Cooling



a - Stainless Steel Separator Plate
b - Gaskets
c - 27-41811 Separator Gasket

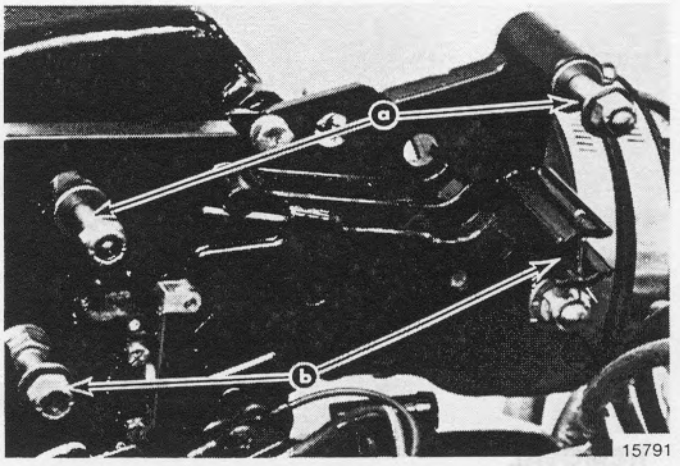
Figure 2. With Closed Cooling

3. **Starboard Manifold:**
   a. Install circuit breaker/slave solenoid and bracket.
   b. Install water separating fuel filter. Reconnect fuel lines. Tighten securely.
   c. Install shift plate assembly. Plug in instrument harness plug and tighten clamp securely.
   d. Connect both shift cables as shown in Figure 3.

IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".

Port Manifold:

a. Install ignition amplifier to exhaust elbow. Tighten bolts securely.



a - Remote Control Shift Cable Anchor Points
b - Drive Unit Shift Cable Anchor Points

Figure 3. Shift Cable Connections

4. Reconnect exhaust bellows and cooling hoses. Tighten clamps securely.
5. Reconnect battery cables to battery. Tighten securely.
6. Start engine and check for fuel, exhaust and water leaks.

MCM 330/370/400/400 Cyclone

NOTICE

MCM 475 Turbo models can follow the procedure as outlined for MCM 370/400, however, the removal of the turbo is not covered in this manual. MCM 440 Cyclone/460 Cyclone models use a different type of exhaust system and its repair is not covered in this manual.

REMOVAL

1. Disconnect battery cables from battery.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust hoses and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect fuel lines from water separating fuel filter and remove fuel filter assembly.
5. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
6. Remove exhaust elbow.
7. Remove end caps.
8. Refer to "Cleaning and Inspection".

INSTALLATION

1. Install new gaskets and end caps on ends of manifold body. Torque to specifications.
2. **MCM 330:** Place new gasket, vented plate, second gasket and exhaust elbow on manifold body. Torque to specifications.
   MCM 370/400/400 Cyclone: Place new gasket and exhaust elbow on manifold body. Torque to specifications.

   IMPORTANT: If engine is equipped with a 3" or 6" riser, refer to "Section 5, Part B".

3. Using new gasket, install manifold. Torque to specifications.
4. **Starboard Manifold:**
   a. Install water separating fuel filter. Connect fuel lines and tighten securely.
5. Reconnect exhaust and water hoses. Tighten clamps securely.
6. Reconnect battery cables to battery. Tighten securely.
7. Start engine and check for fuel, exhaust and water leaks.

MCM 330 (B-W)/MIE 230/260/340

REMOVAL

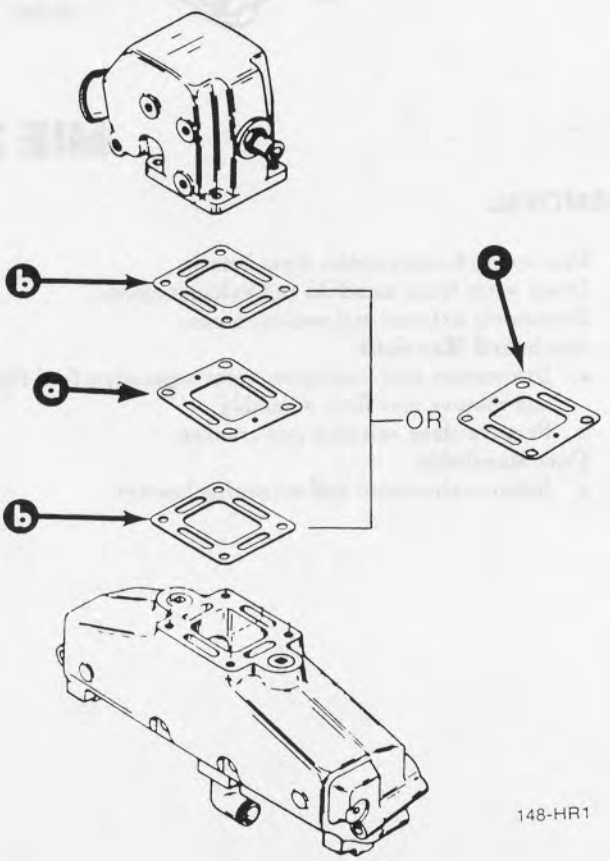
1. Disconnect battery cables from battery.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect fuel lines from water separating fuel filter and remove filter assembly.
   b. Disconnect instrument harness plug from engine harness.
   c. Remove circuit breaker/slave solenoid and bracket.

   Port Manifold:
   a. Remove ignition amplifier from exhaust elbow.
   b. Remove remote oil filter and bracket.
5. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
6. Remove exhaust elbow.
7. Refer to "Cleaning and Inspection".

INSTALLATION

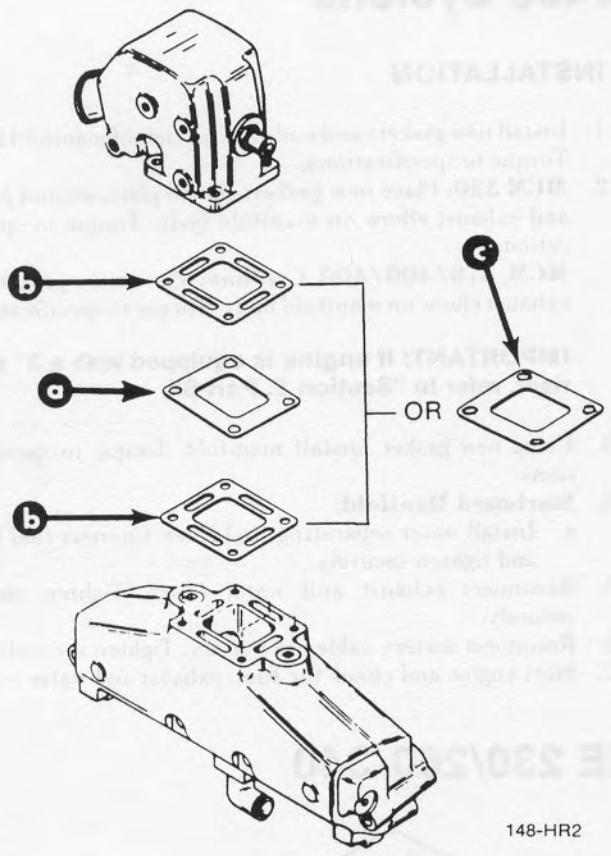
1. Using new gasket, install exhaust manifold to cylinder head. Torque to specifications.
2. Install exhaust elbow as shown in Figure 1. Torque to specifications.

IMPORTANT: If engine is equipped with a 3" or 6" riser, refer to "Section 5, Part B". If engine is equipped with a closed cooling system, refer to Figure 2.



a - Stainless Steel Restrictor Plate
b - Gaskets
c - 27-41813 Restrictor Gasket

Figure 1. Without Closed Cooling



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3. **Starboard Manifold:**
   a. Install circuit breaker/slave solenoid and bracket.
   b. Install water separating fuel filter. Reconnect fuel lines. Tighten securely.
   c. Plug in instrument harness plug and tighten clamp securely.

   Port Manifold:
   a. Install ignition amplifier to exhaust elbow. Tighten bolts securely.
   b. Install remote oil filter and bracket. Tighten fasteners securely.
4. Reconnect exhaust and cooling hoses. Tighten clamps securely.
5. Reconnect battery cables to battery. Tighten securely.
6. Start engine and check for fuel, exhaust and water leaks.

a - Stainless Steel Separator Plate
b - Gaskets
c - 27-41811 Separator Gasket

Figure 2. With Closed Cooling

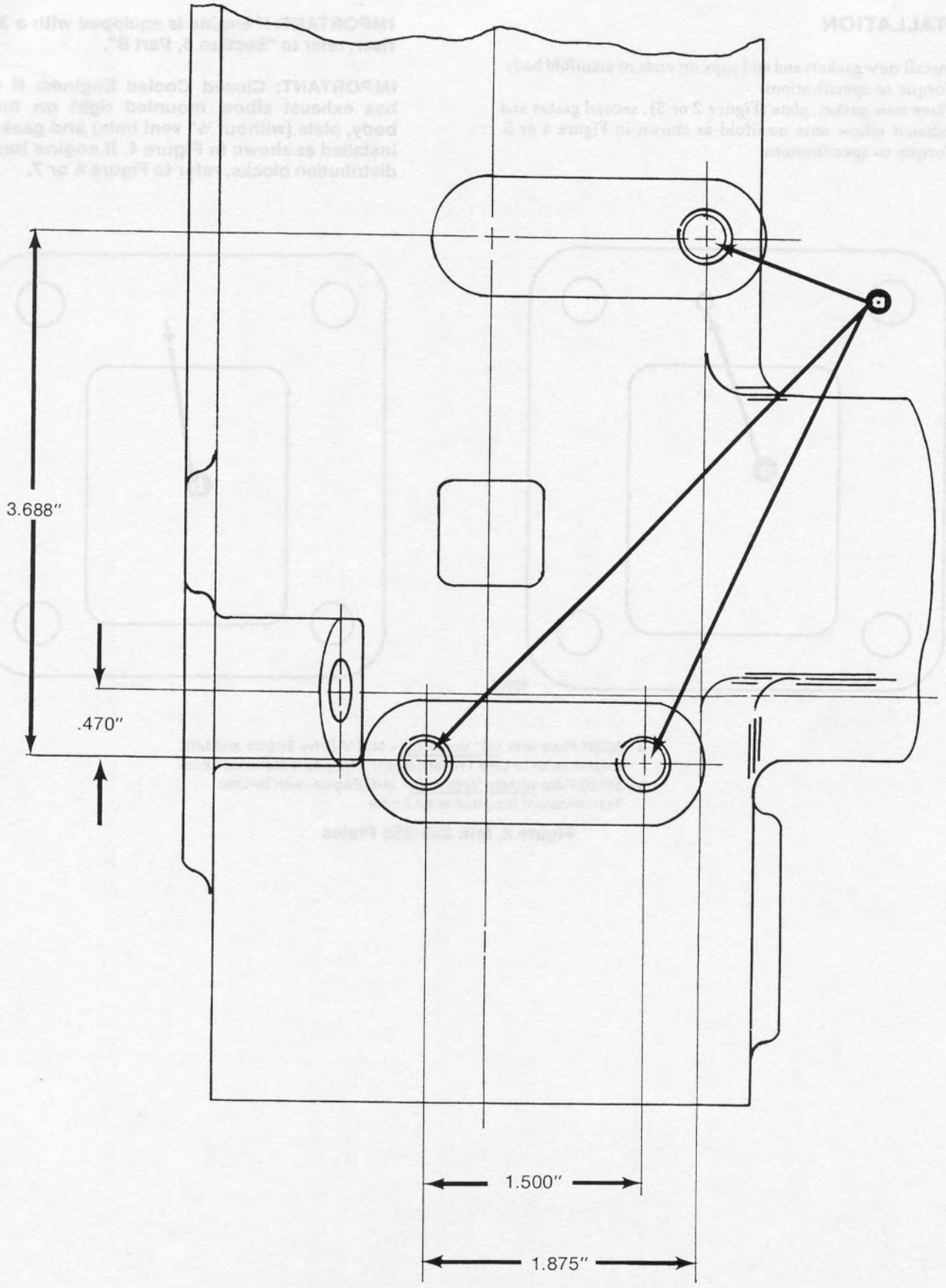
MIE 228/255/330

REMOVAL

1. Disconnect battery cables from battery.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect fuel lines from water separating fuel filter and remove fuel filter assembly.
   b. Remove slave solenoid and bracket.

   Port Manifold:
   a. Remove alternator and mounting bracket.
5. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
6. Remove exhaust elbow.
7. Remove end caps.
8. Refer to "Cleaning and Inspection".

MIE 228/255 V-DRIVE WITH REVERSED EXHAUST MANIFOLDS: These V-Drive engines had the exhaust outlet (of the manifold) at the front (circulating pump) end of the engine. If the manifold (with the alternator mounted to it) has to be replaced, refer to Figure 1 for drilling instructions to new manifold.



a - 5/16″ Drill - .680″ Deep
3/8-16 UNC-2B Tap - .560″ Deep

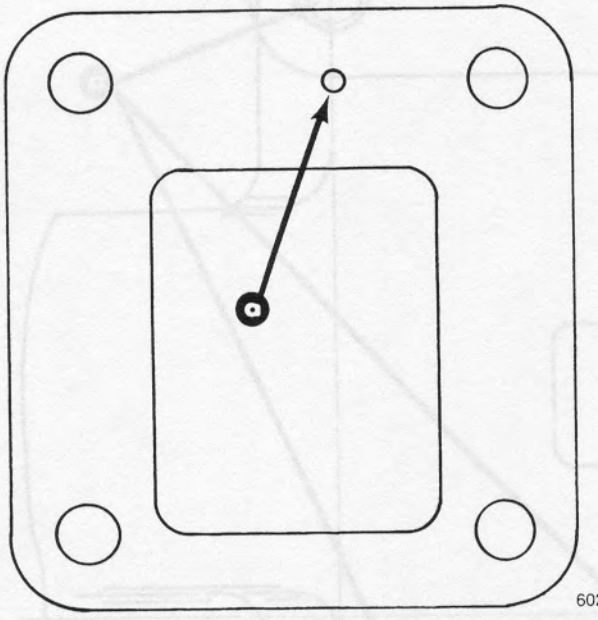
Figure 1. MIE 228/255 V-Drive with Reversed Manifolds

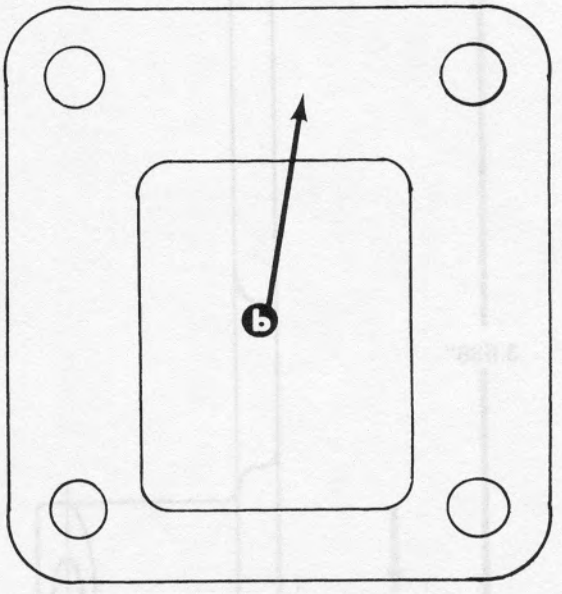
INSTALLATION

1. Install new gaskets and end caps on ends of manifold body. Torque to specifications.
2. Place new gasket, plate (Figure 2 or 3), second gasket and exhaust elbow onto manifold as shown in Figure 4 or 5. Torque to specifications.

IMPORTANT: If engine is equipped with a 3" or 6" riser, refer to "Section 5, Part B".

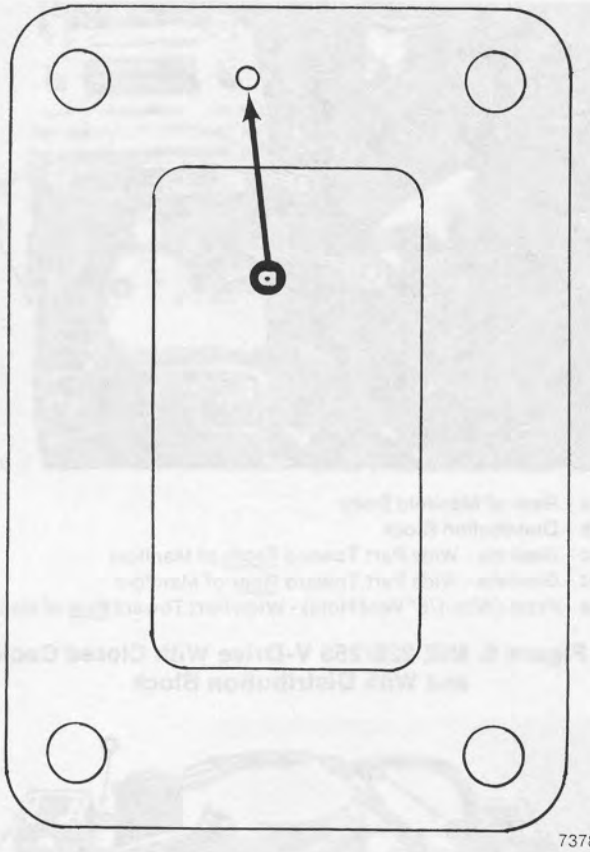
IMPORTANT: Closed Cooled Engines: If engine has exhaust elbow mounted right on manifold body, plate (without 1/8" vent hole) and gaskets are installed as shown in Figure 4. If engine has water distribution blocks, refer to Figure 6 or 7.

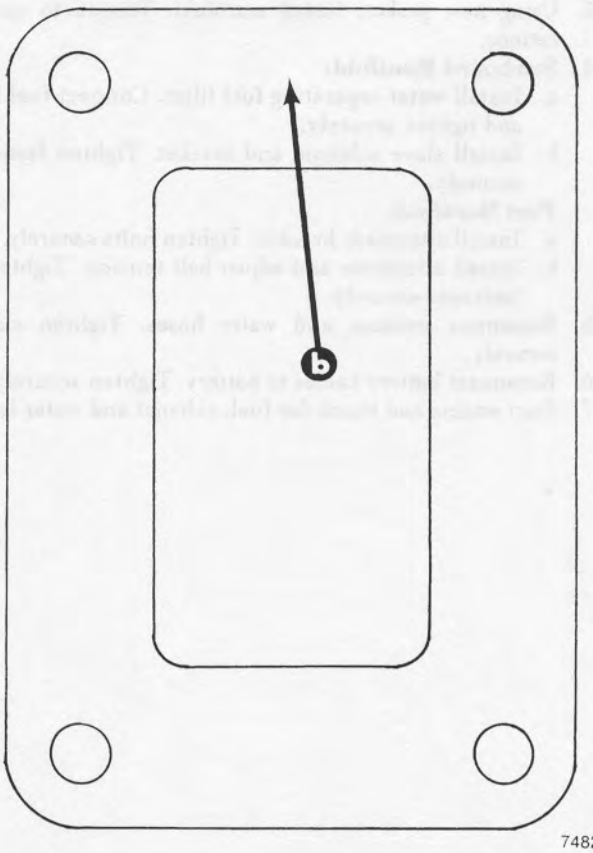




a - 60207 Plate with 1/8" Vent Hole - MIE V-Drive Engine and MIE Engine (with In-Line Transmission) if Engine is Mounted Level
b - 55730 Plate without Vent Hole - MIE Engine (with In-Line Transmission) Mounted at an Angle

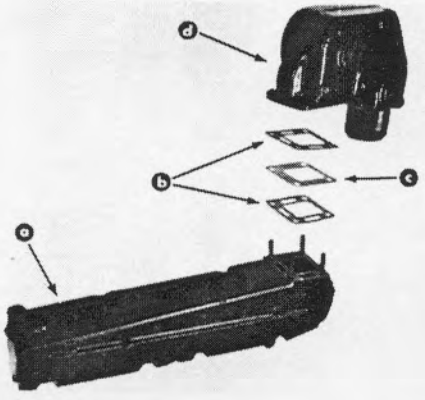
Figure 2. MIE 228/255 Plates





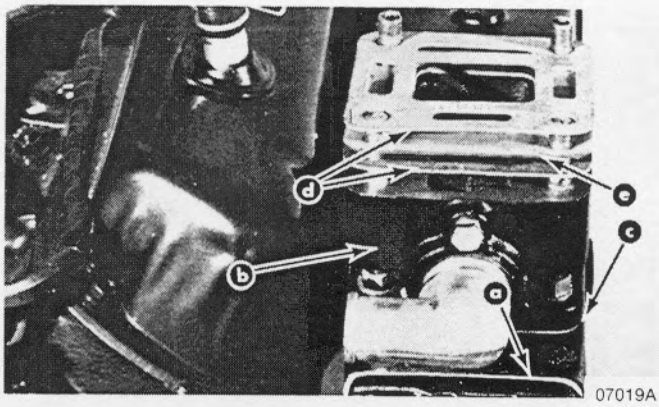
a - 73782 Plate with 1/8" Vent Hole - MIE V-Drive Engine and MIE Engine (with In-Line Transmission) if Engine is Mounted Level
b - 74829 Plate without Vent Hole - MIE Engine (with In-Line Transmission) Mounted at an Angle

Figure 3. MIE 330 Plates



a - Front of Manifold Body
b - Gaskets - MIE 228/255: Wide Part Toward Front of Manifold. MIE 330: Either Way.
c - Plate - MIE 228/255: Wide Part Toward Front of Manifold. MIE 330 With 1/8" Vent: Toward Front of Manifold. MIE 330 Without Vent: Either Way.
d - Exhaust Elbow

Figure 4. MIE 228/255/330 Without Closed Cooling and Without Distribution Block

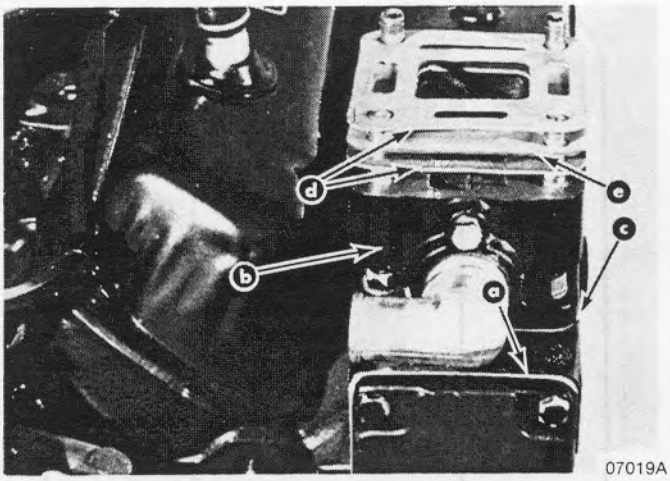


a - Rear of Manifold Body
b - Distribution Block
c - Gasket - Wide Part Toward Front of Manifold
d - Gaskets - Wide Part Toward Rear of Manifold
e - Plate (With 1/8" Vent Hole) - Wide Part Toward Rear of Manifold

Figure 5. MIE 228/255 V-Drive Without Closed Cooling and With Distribution Block

3. Using new gasket, install manifold. Torque to specifications.
4. **Starboard Manifold:**
   a. Install water separating fuel filter. Connect fuel lines and tighten securely.
   b. Install slave solenoid and bracket. Tighten fasteners securely.

   Port Manifold:
   a. Install alternator bracket. Tighten bolts securely.
   b. Install alternator and adjust belt tension. Tighten all fasteners securely.
5. Reconnect exhaust and water hoses. Tighten clamps securely.
6. Reconnect battery cables to battery. Tighten securely.
7. Start engine and check for fuel, exhaust and water leaks.



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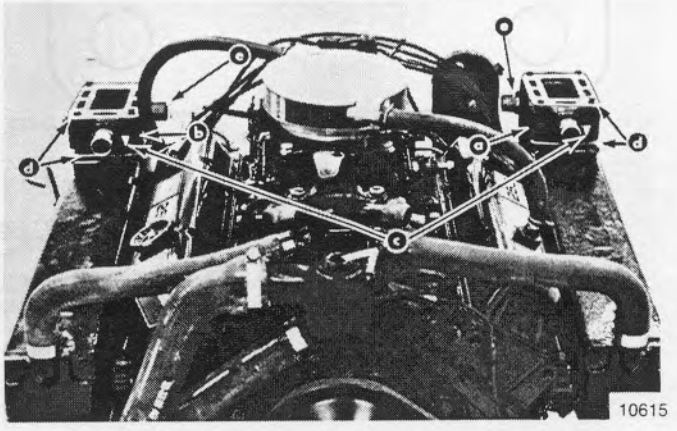
a - Rear of Manifold Body
b - Distribution Block
c - Gaskets - Wide Part Toward Front of Manifold
d - Gaskets - Wide Part Toward Rear of Manifold
e - Plate (With 1/8" Vent Hole) - Wide Part Toward Rear of Manifold

Figure 6. MIE 228/255 V-Drive With Closed Cooling and With Distribution Block



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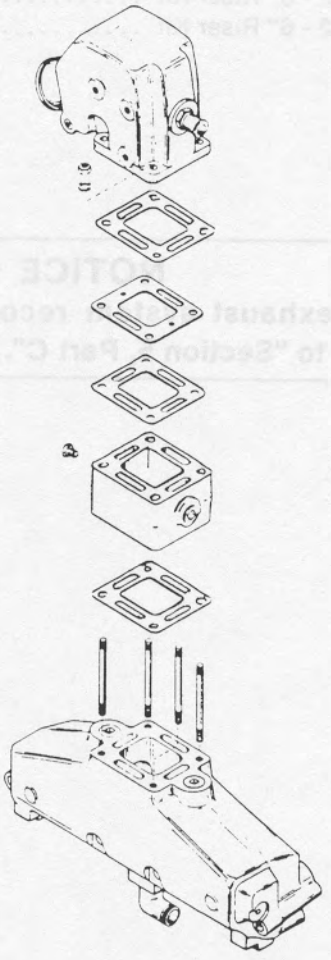
a - Port Distribution Block
b - Starboard Distribution Block
c - Cast Arrow (Must Point Down)
d - Gasket (Install One Above and One Below Each Block
e - Hose Fitting (Must Point Inward)

Figure 7. MIE 330 V-Drive With Closed Cooling and With Distribution Block

SECTION 5 - EXHAUST SYSTEM

PART B - EXHAUST RISERS



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MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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NOTICE

For exhaust system recommendations, refer to "Section 5, Part C".

KIT IDENTIFICATION

MODEL	3" RISER	6" RISER
MCM 120	(Note 1)	(Note 1)
MCM 120R	61851A3	57952A5
MCM 140	61851A2	57952A2
MCM 140R	61851A3	57952A5
MCM 165	61851A2	57952A2
MCM 470	61851A2	57952A2
MCM 470R	(Note 1)	(Note 1)
MCM 485	(Note 1)	(Note 1)
MCM 488R	(Note 1)	(Note 1)
MCM 898	61851A2	57952A2
MCM 898R	93320A2	93322A2
MCM 228	61851A2	57952A2
MCM 228R	93320A2	93322A2
MCM 260	61851A2	57952A2
MCM 260R	93320A2	93322A2
MCM 330	61811A4	53452A2
MCM 330 (B-W)	93320A2	93322A2
MCM 370/400	61811A4	53452A2
MIE 470	61851A1	57952A4
MIE 228	61851A2	57952A2
MIE 230	93320A2	93322A2
MIE 255	61851A2	57952A2
MIE 260	93320A2	93322A2
MIE 330	61811A4	53452A2
MIE 340	93320A2	93322A2

NOTE 1: Riser Kits not available for this model.

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Exhaust Elbow	20-25 (27-34)
Exhaust Riser	20-25 (27-34)

SEALANTS

SEALANTS	
92-34227--1	Quicksilver Perfect Seal

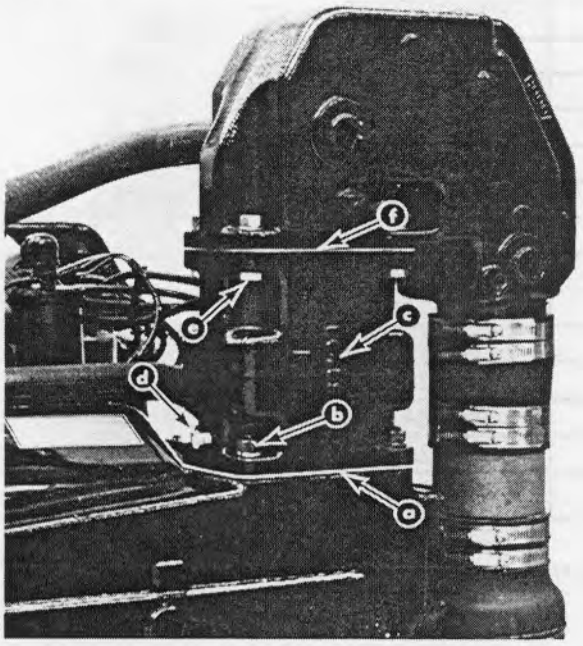
53452A2 - 6" RISER KIT

REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1, 2 or 3.

IMPORTANT: Models with Stainless Steel Separator Plate: Separator plate must be installed as shown or steam pocket will form in exhaust manifold.

5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Closed Cooling System: Refill closed cooling system.
8. Check for leaks after starting engine.



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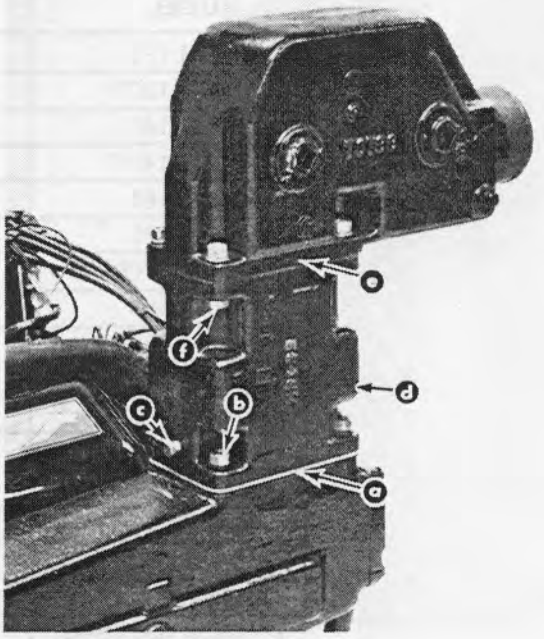
a - Stainless Steel Separator Plate with Gasket on Each Side
b - Lockwashers and Nuts (4)
c - 6" Riser
d - Drain Plug - Down and Toward Front of Boat
e - Screw, Lockwasher and Nut (4)
f - Gasket

Figure 1. MCM 330

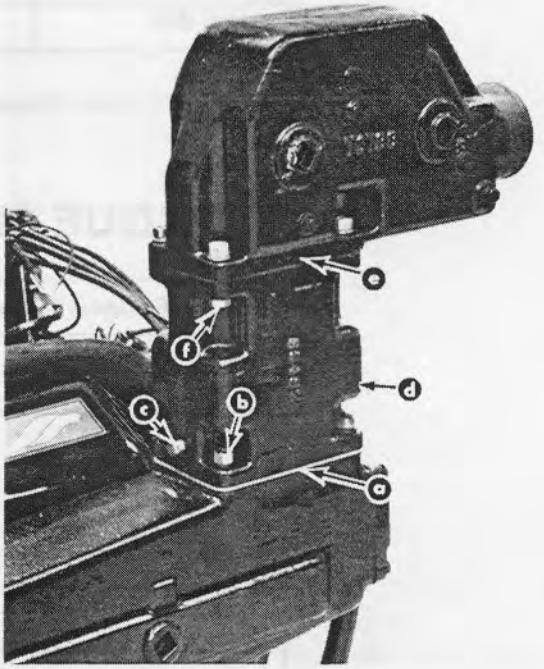


12097

a - Gasket
b - Lockwashers and Nuts (4)
c - Drain Plug - Down and Toward Front of Boat
d - 6" Riser
e - Gasket
f - Screws, Lockwashers and Nuts (4)

Figure 2. MCM 370/400/400 Cyclone

a - Stainless Steel Separator Plate with Gaskets on Each Side (Note 1)
b - Lockwashers and Nuts (4)
c - Drain Plug - Down and Toward Front of Boat
d - 6" Riser
e - Gasket
f - Screw, Lockwasher and Nut (4)



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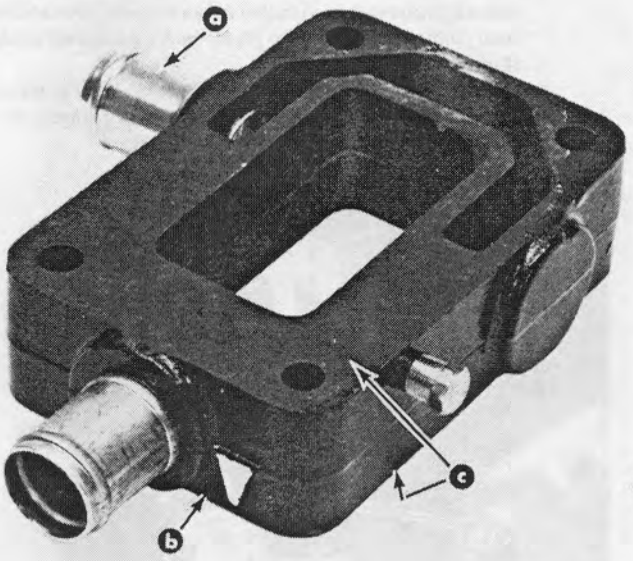
NOTE 1: On engines equipped with Closed Cooling System water distribution blocks, block will be installed between exhaust manifold and riser (instead of separator plate) with a gasket on each side. (Figure 4)

Figure 3. MIE 330



15053

a - Fitting - Toward Center of Engine
b - Arrow - Pointing Down
c - Gasket on Each Side

Figure 4. Distribution Block

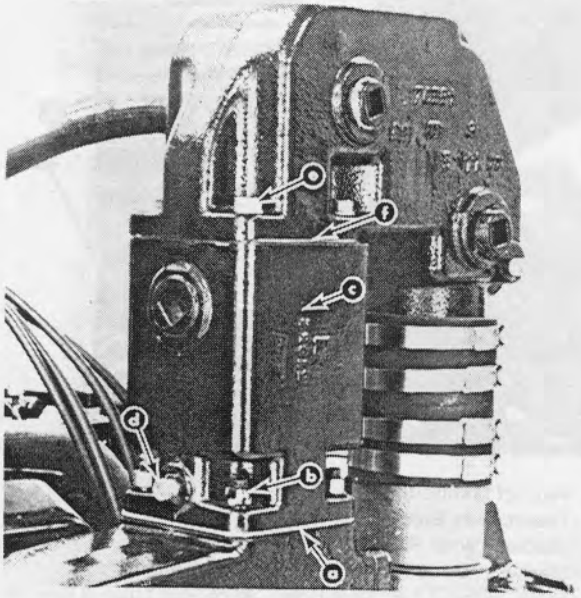
57952A2 - 6" RISER KIT

REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1 or 3.

IMPORTANT: Models with Stainless Steel Separator Plate: Separator plate must be installed as shown or steam pocket will form in exhaust manifold.

5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Closed Cooling System: Refill closed cooling system.
8. Check for leaks after starting engine.

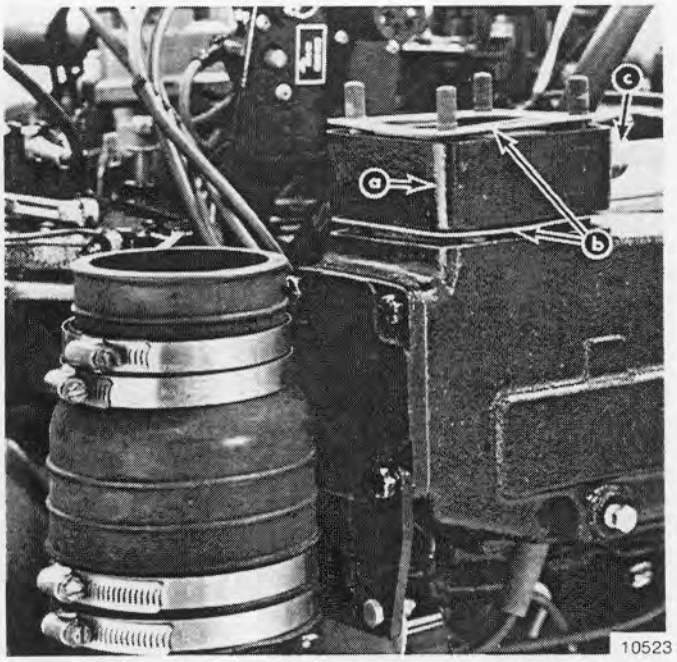


12398

a - MCM 140/165: Gasket - Wide Part Toward FRONT of Manifold. MCM 470/898/228/260: Stainless Steel Separator Plate with Gasket on Each Side - Wide Part Toward FRONT of Manifold (Note 1)
b - Lockwashers and Nuts (4)
c - 6" Riser
d - Drain Plug - Down and Toward Front of Manifold
e - Screws and Lockwashers (4)
f - Gasket

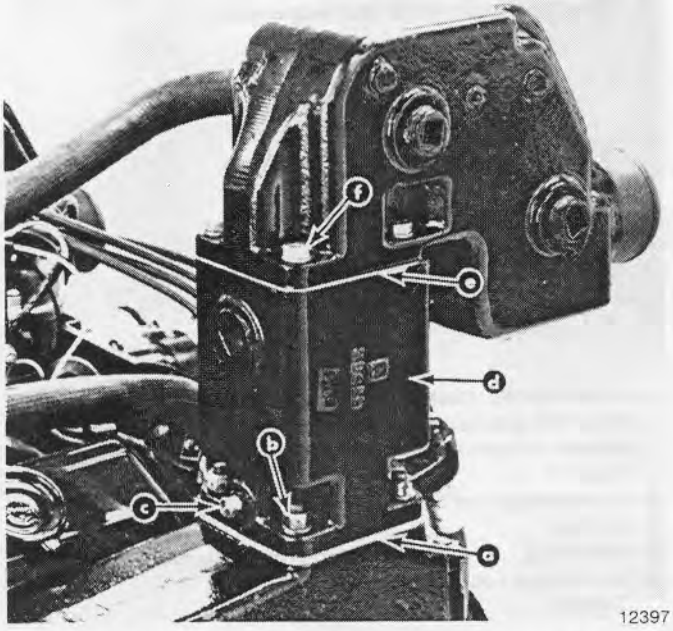
NOTE 1: MCM 898/228/260 equipped with Closed Cooling System water distribution blocks, block will be installed between exhaust manifold and riser (instead of separator plate) with a gasket on each side. (Figure 2)

Figure 1. MCM 140/165/470/898/228/260



a - Distribution Block (Water Passages Toward Manifold)
b - Wide Part of Gasket Forward
c - Hose Fitting Forward

Figure 2. MCM 898/228/260 Engines with Closed Cooling System



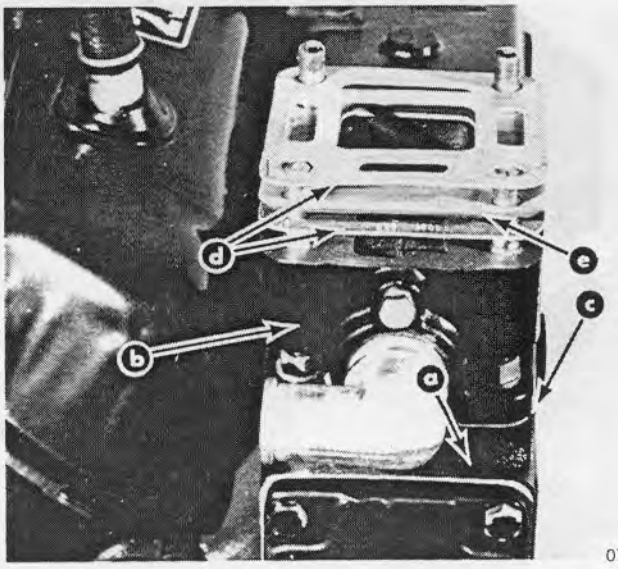
a - Stainless Steel Separator Plate with Gasket on Each Side - Wide Part Toward FRONT of Manifold (Note 1)
b - Lockwashers and Nuts (4)
c - Drain Plug - Down and Toward Front of Manifold (Note 2)
d - 6" Riser
e - Gasket - Make Sure Wide of Gasket is Over Wide Part of Riser
f - Screws and Lockwashers (4)

Figure 3. MIE 228/255

NOTES:

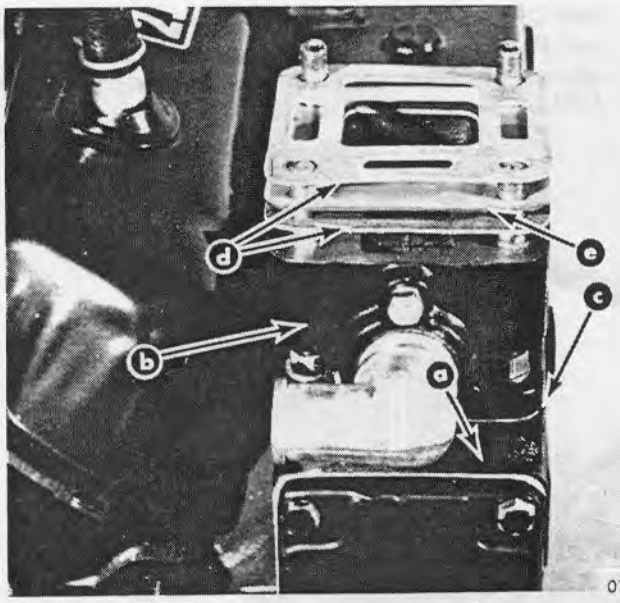
1) MIE 228/255 V-Drives equipped with water distribution blocks, block will be installed between exhaust manifold and riser (instead of separator plate) with a gasket on each side. (Figure 4 or 5)

2) On models with water distribution block; Look at water passages in block and riser. Install riser (and gaskets) so water passages line up with passages in block.



a - Rear of Manifold Body
b - Distribution Block
c - Gasket - Wide Part Toward Front of Manifold
d - Gaskets - Wide Part Toward Rear of Manifold
e - Plate (with 1/8" Vent Hole) - Wide Part Toward Rear of Manifold

Figure 4. MIE 228/255 V-Drive Without Closed Cooling and With Distribution Block



a - Rear of Manifold Body
b - Distribution Block
c - Gasket - Wide Part Toward Front of Manifold
d - Gaskets - Wide Part Toward Rear of Manifold
e - Plate (without 1/8" Vent Hole) - Wide Part Toward Rear of Manifold

Figure 5. MIE 228/255 V-Drive With Closed Cooling and With Distribution Block

57952A4 - 6" RISER KIT

REPLACEMENT

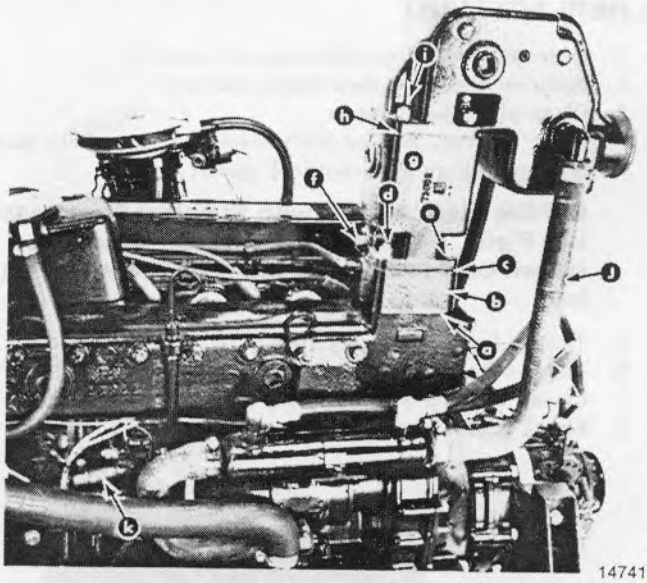
1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.

IMPORTANT: Gaskets, exhaust elbow riser and distribution block MUST BE installed correctly (as described in steps 4, 5, 6 and 7) or water will leak into exhaust manifold during operation.

4. Coat both sides of one gasket (gasket with water passages) with Perfect Seal, then position gasket on exhaust manifold being certain that passages in gasket align with passages in manifold. Reinstall distribution block on manifold, being certain that by-pass hose connection is toward front of boat, as shown in Figure 1.
5. Coat both sides of gasket (gasket without water passages) with Perfect Seal, then position gasket on water distribution block. Position gasket so that large opening is centered over exhaust passage.
6. Place exhaust elbow riser on water distribution block with drain plug downward and toward front of boat. Torque nuts to specifications.

IMPORTANT: Gasket (with water passages) MUST BE installed on top of riser. DO NOT install gasket (without water passages) on top of riser, as this will cause riser to overheat.

7. Coat both sides of remaining gasket (gasket with water passages) with Perfect Seal, then position gasket on top of riser, being certain that passages in gasket align with passages in riser. Install exhaust elbow and torque nuts to specifications.
8. Tighten hose clamps securely.
9. Refill closed cooling system.
10. Check for leaks after starting engine.



a - Gasket (with Water Passages)
b - Water Distribution Block
c - Gasket (without Water Passages)
d - Studs
e - Nuts and Lockwashers
f - Drain Plug
g - Exhaust Elbow Riser
h - Gasket (with Water Passages)
i - Studs
j - Hose
k - Hose

Figure 1. MIE 470 with In-Line Transmission

57952A5 - 6" RISER KIT

REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1.

IMPORTANT: Gaskets MUST BE installed as shown in Figure 1.

5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Check for leaks after starting engine.

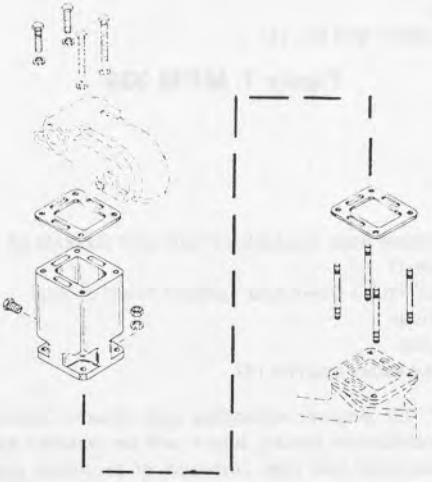


Figure 1. MCM 120R/140R

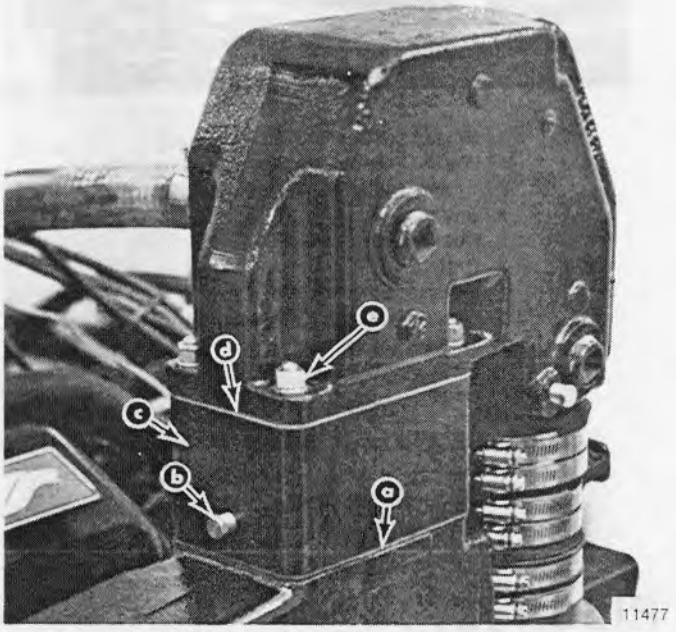
61811A4 - 3" RISER KIT

REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1, 2 or 3.

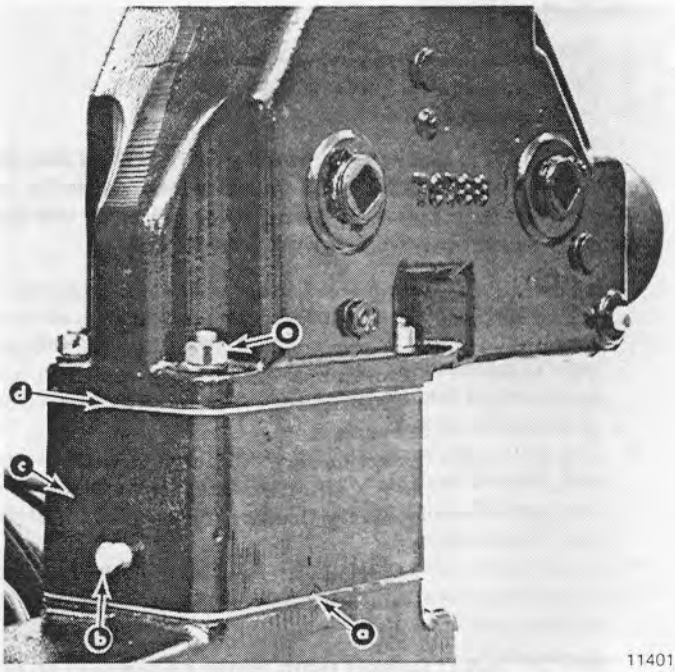
IMPORTANT: Models with Stainless Steel Separator Plate: Separator plate must be installed as shown or steam pocket will form in exhaust manifold.

5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Closed Cooling System: Refill closed cooling system.
8. Check for leaks after starting engine.



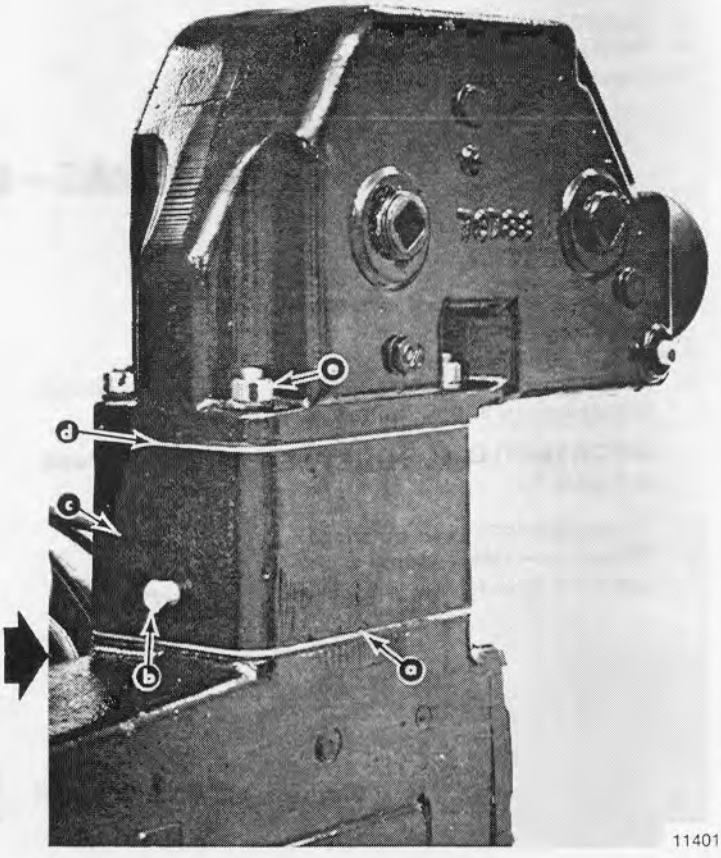
a - Stainless Steel Separator Plate with Gaskets on Each Side
b - Drain Plug - Down and Toward Front of Boat
c - 3" Riser
d - Gasket
e - Lockwasher and Nut (4)

Figure 1. MCM 330



a - Gasket
b - Drain Plug - Down and Toward Front of Boat
c - 3" Riser
d - Gasket
e - Lockwasher and Nut (4)

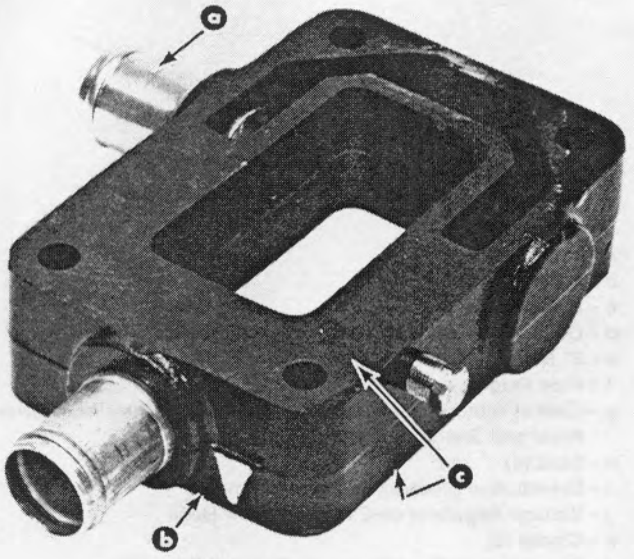
Figure 2. MCM 370/400/400 Cyclone



a - Stainless Steel Separator Plate with Gaskets on Each Side (Note 1)
b - Drain Plug - Down and Toward Front of Boat
c - 3" Riser
d - Gasket
e - Lockwasher and Nut (4)

NOTE 1: On engines equipped with Closed Cooling System water distribution blocks, block will be installed between exhaust manifold and riser (instead of separator plate) with a gasket on each side. (Figure 4)

Figure 3. MIE 330



15053

a - Fitting - Toward Center of Engine
b - Arrow - Pointing Down
c - Gasket on Each Side

Figure 4. Distribution Block

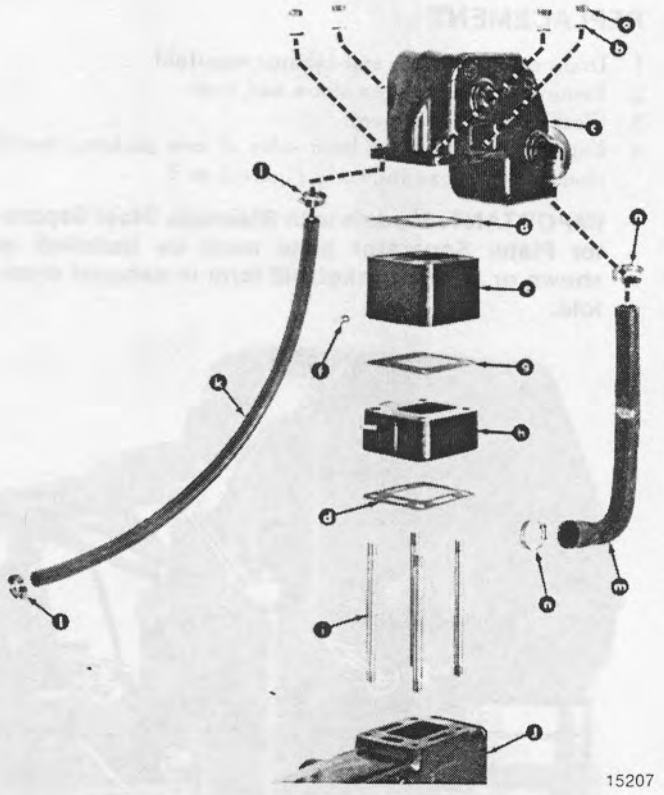
61851A1 - 3" RISER KIT

REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1 or 2.

IMPORTANT: Install gaskets so that large end is toward front of boat. Install riser with drain plug end downward and plug toward front of boat. Riser and gaskets MUST BE installed as indicated.

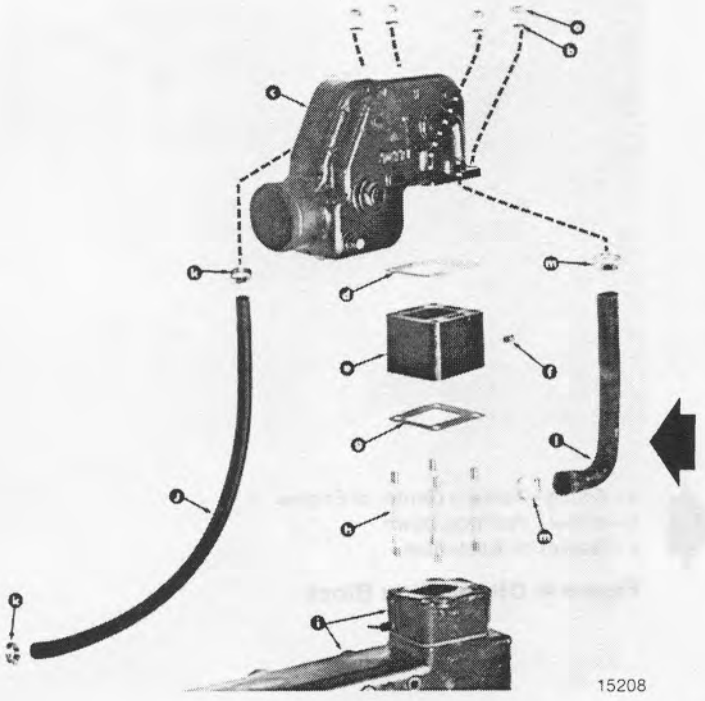
5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Refill closed cooling system.
8. Check for leaks after starting engine.



15207

a - Nut (4)
b - Lockwasher (4)
c - Exhaust Elbow
d - Gasket with Water Passages - Toward Front of Boat
e - 3" Riser
f - Pipe Plug
g - Gasket without Water Passages - MUST BE Installed Between Riser and Distribution Block
h - Distribution Block
i - Stud (4)
j - Exhaust Manifold
k - Voltage Regulator-to-Exhaust Elbow Hose
l - Clamp (2)
m - Transmission Fluid Cooler-to-Exhaust Elbow Hose
n - Clamp (2)

Figure 1. MIE 470 with In-Line Transmission



a - Nut (4)
b - Lockwasher (4)
c - Exhaust Elbow
d - Gasket with Water Passages - Toward Front of Boat
e - 3" Riser
f - Pipe Plug
g - Gasket without Water Passages - MUST BE Installed Between Riser and Distribution Block
h - Stud (4)
i - Distribution Block and Exhaust Manifold
j - Voltage Regulator-to-Exhaust Elbow Hose
k - Clamp (2)
l - Transmission Fluid Cooler-to-Exhaust Elbow Hose
m - Clamp (2)

Figure 2. MIE 470 with V-Drive Transmission

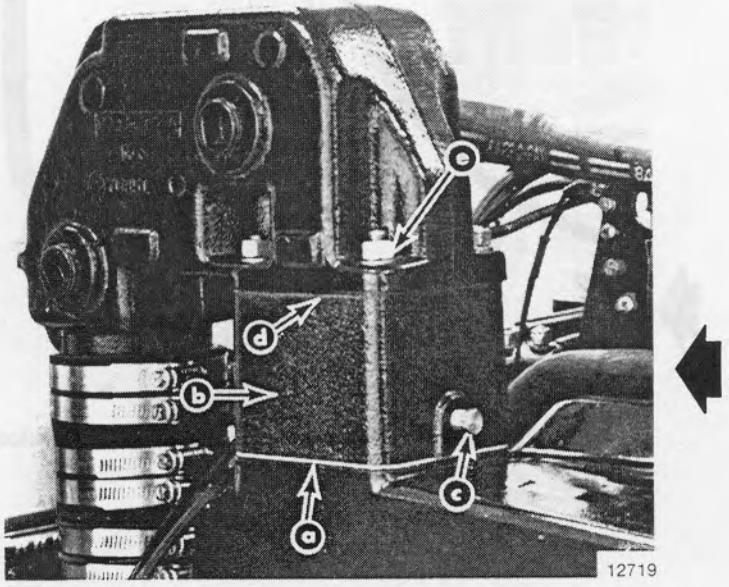
61851A2 - 3" RISER KIT

REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1 or 3.

IMPORTANT: Models with Stainless Steel Separator Plate: Separator plate must be installed as shown or steam pocket will form in exhaust manifold.

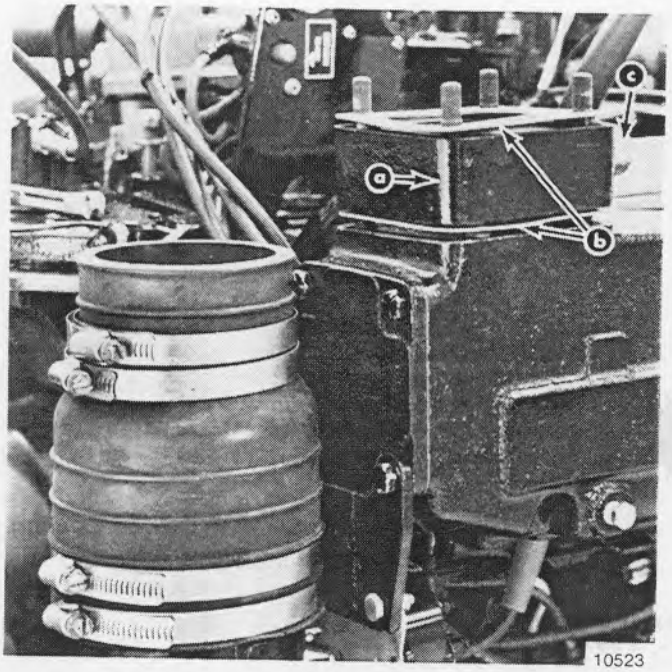
5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Closed Cooling System: Refill closed cooling system.
8. Check for leaks after starting engine.



a - MCM 140/165: Gasket - Wide Part Toward FRONT of Manifold. MCM 470/898/228/260: Stainless Steel Separator Plate with Gaskets on Each Side - Wide Part Toward FRONT of Manifold (Note 1)
b - 3" Riser
c - Drain Plug - Down and Toward Front of Manifold
d - Gasket
e - Lockwashers and Nuts (4)

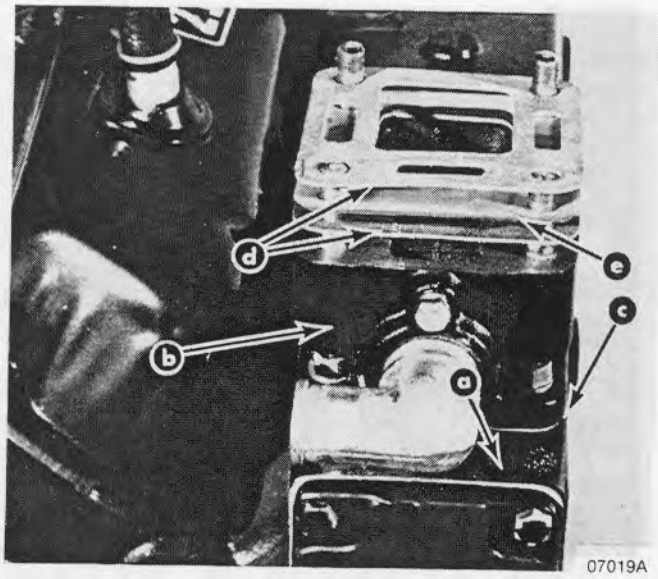
NOTE 1: MCM 898/228/260 equipped with Closed Cooling System water distribution blocks, block will be installed between exhaust manifold and riser (instead of separator plate) with a gasket on each side. (Figure 2)

Figure 1. MCM 140/165/470/898/228/260



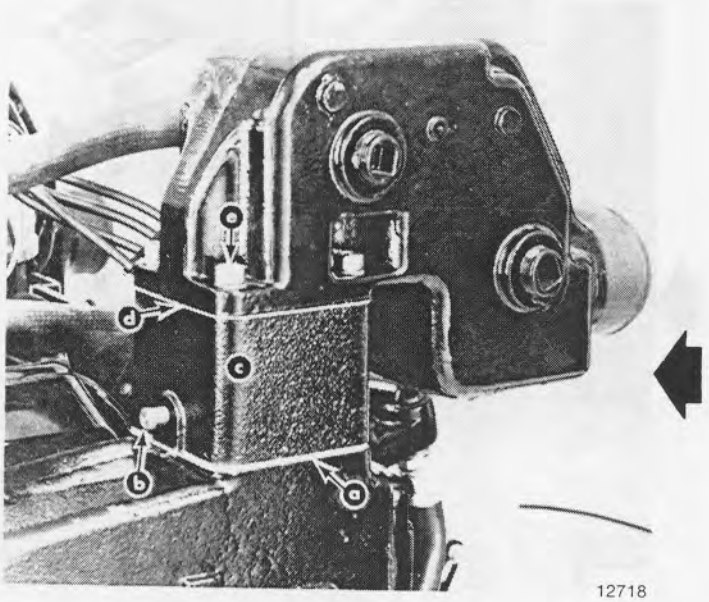
a - Distribution Block (Water Passages Toward Manifold)
b - Wide Part of Gasket Forward
c - Hose Fitting Forward

Figure 2. MCM 898/228/260 Engines with Closed Cooling System



a - Rear of Manifold Body
b - Distribution Block
c - Gasket - Wide Part Toward Front of Manifold
d - Gaskets - Wide Part Toward Rear of Manifold
e - Plate (with 1/8" Vent Hole) - Wide Part Toward Rear of Manifold

Figure 4. MIE 228/255 V-Drive Without Closed Cooling and With Distribution Block



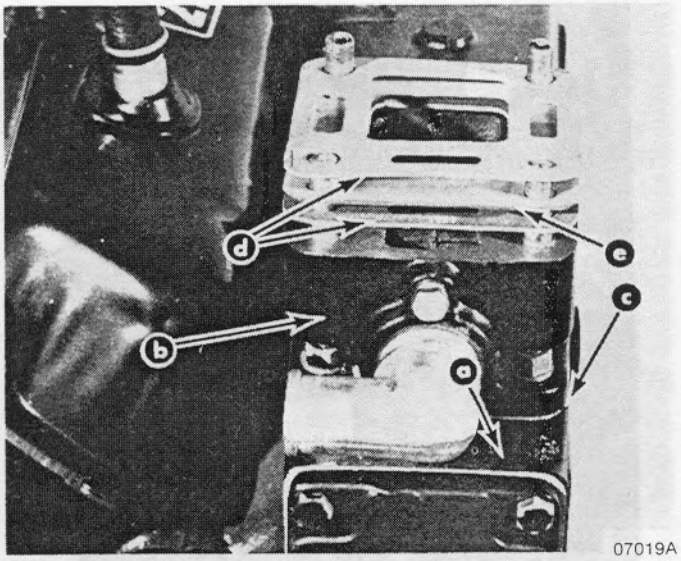
a - Stainless Steel Separator Plate with Gaskets on Each Side - Wide Part Toward FRONT of Manifold (Note 1)
b - Drain Plug - Down and Toward Front of Manifold (Note 2)
c - 3" Riser
d - Gasket - Make Sure Wide Part of Gasket is Over Wide Part of Riser
e - Lockwasher and Nut (4)

NOTES:

1) MIE 228/255 V-Drives equipped with water distribution blocks, block will be installed between exhaust manifold and riser (instead of separator plate) with a gasket on each side. (Figure 4 or 5)

2) On models with water distribution block; Look at water passages in block and riser. Install riser (and gaskets) so water passages line up with passages in block.

Figure 3. MIE 228/255



a - Rear of Manifold Body
b - Distribution Block
c - Gasket - Wide Part Toward Front of Manifold
d - Gaskets - Wide Part Toward Rear of Manifold
e - Plate (without 1/8" Vent Hole) - Wide Part Toward Rear of Manifold

Figure 5. MIE 228/255 V-Drive With Closed Cooling and With Distribution Block

61851A3 - 3" RISER KIT

REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1.

   IMPORTANT: Gaskets MUST BE installed as shown in Figure 1.

5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Check for leaks after starting engine.

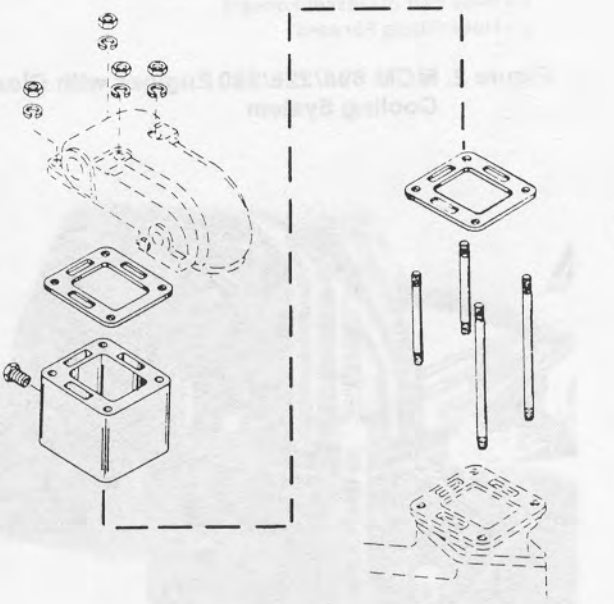


Figure 1. MCM 120R/140R

93320A2 - 3" RISER KIT

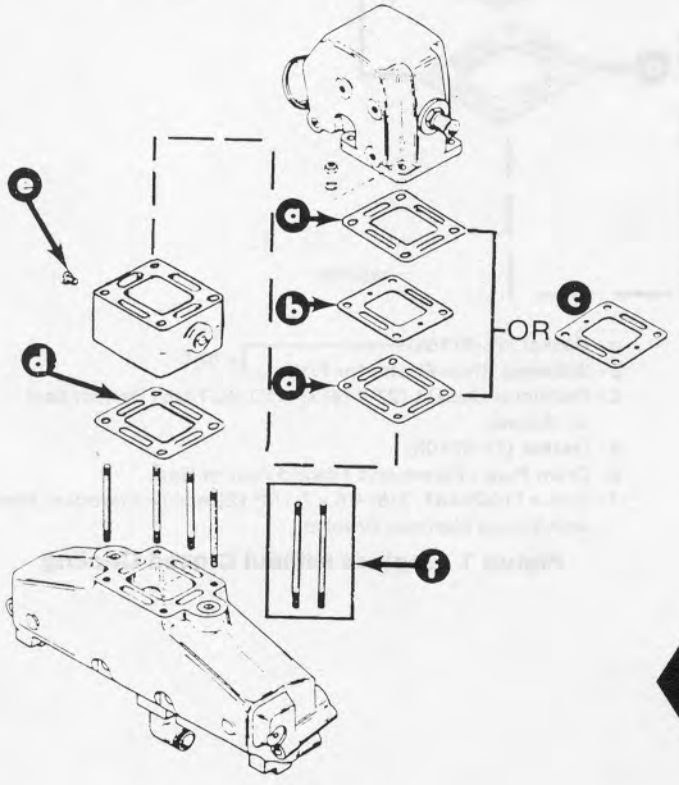
REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove ignition amplifier or shift plate (MCM only).
3. Remove fasteners, then elbow and riser.
4. Clean all gasket surfaces.
5. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1 or 2.

   IMPORTANT: Gaskets, restrictor plate (or separator plate and riser must be installed as shown in Figure 1 or 2.

   IMPORTANT: If engine is equipped with closed cooling, stainless steel separator plate must be installed below 3" risers. If plate is installed above 3" riser, a steam pocket will form in exhaust manifolds during operation.

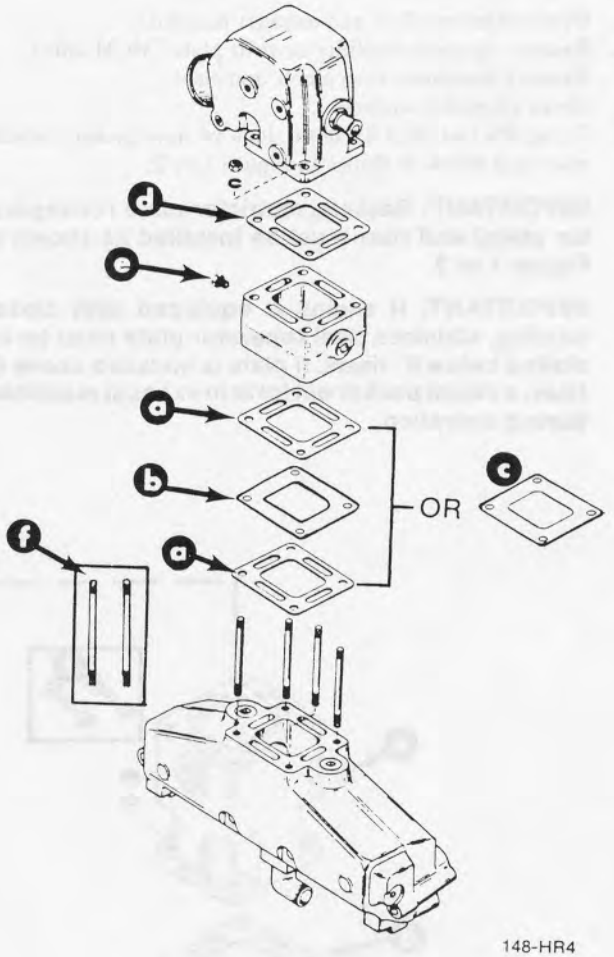
6. Torque fasteners to specifications.
7. **Elbow with ignition amplifier:** Reinstall ignition amplifier and wiring harness mounting bracket onto exhaust elbow using original attaching hardware. Be sure to reconnect amplifier and wiring harness ground wires to one of the attaching screws and that amplifier spacers are installed between amplifier and exhaust elbow. Tighten screws securely.
8. **Elbow with shift plate (MCM only):** Reinstall shift plate. Tighten fasteners securely. Readjust shift cables as outlined in "Stern Drive Service Manual".
9. Tighten hose clamps securely.
10. **Closed Cooling System:** Refill closed cooling system.
11. Check for leaks after starting engine.



148-HR3

a - Gasket (27-87105) — or C
b - Stainless Steel Restrictor Plate — or C
c - Restrictor Gasket (27-41813) - DO NOT Use Perfect Seal on Gasket
d - Gasket (27-87105)
e - Drain Plug - Down and Toward Rear of Boat
f - Stud [16-34713, 3/8" x 6-1/2" (165mm)] - Port Manifold with Remote Oil Filter (if Equipped)

Figure 1. Engines without Closed Cooling



148-HR4

a - Gasket (27-87105) — or C
b - Stainless Steel Separator Plate — or C
c - Separator Gasket (27-41811) - DO NOT Use Perfect Seal on Gasket
d - Gasket (27-87105)
e - Drain Plug - Down and Toward Rear of Boat
f - Stud [16-34713, 3/8" x 6-1/2" (165mm)] - Port Manifold with Remote Oil Filter (if Equipped)

Figure 2. Engines with Closed Cooling

93322A2 - 6" RISER KIT

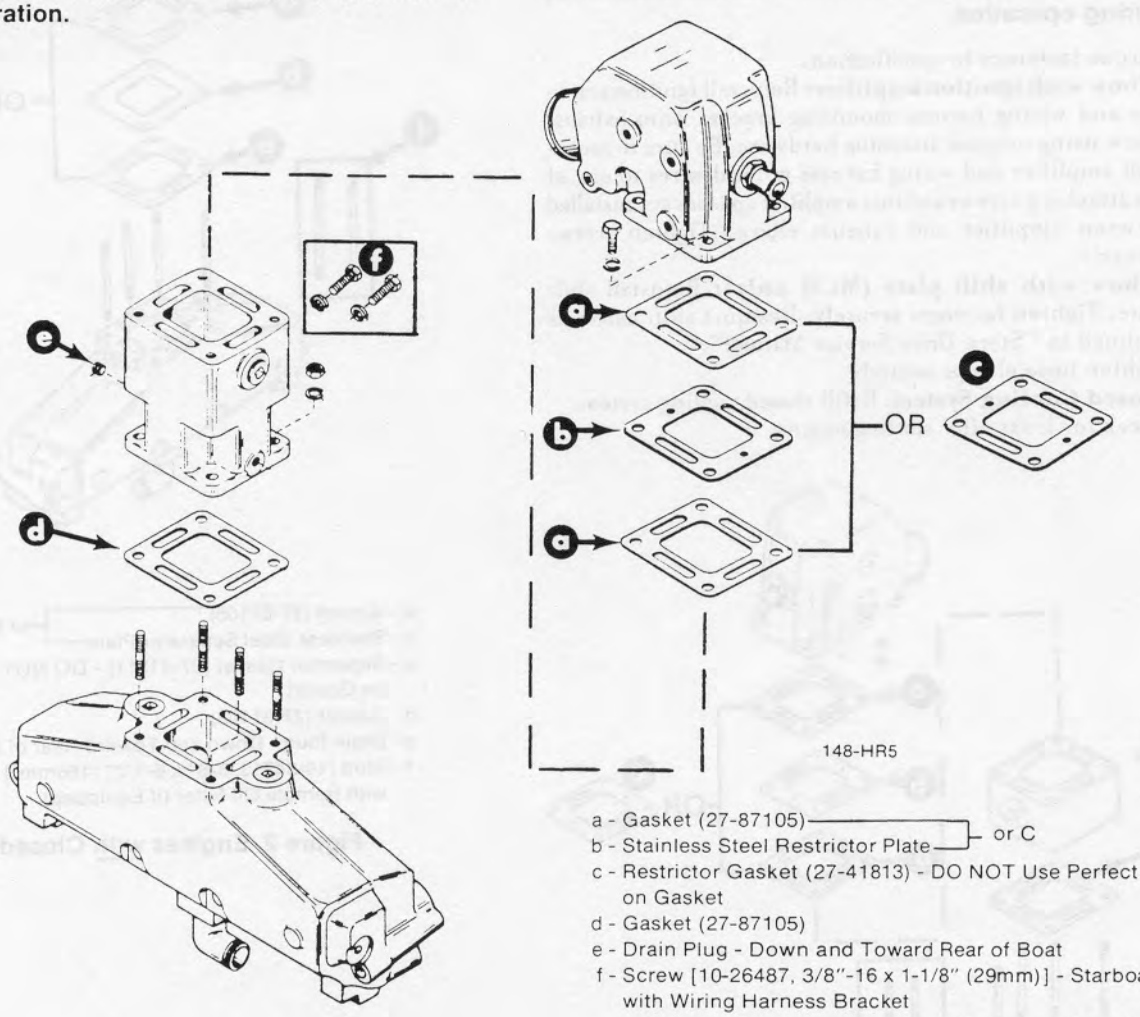
REPLACEMENT

1. Drain exhaust elbow and exhaust manifold.
2. Remove ignition amplifier or shift plate (MCM only).
3. Remove fasteners, then elbow and riser.
4. Clean all gasket surfaces.
5. Using Perfect Seal on both sides of new gaskets, install riser and elbow as shown in Figure 1 or 2.

IMPORTANT: Gaskets, restrictor plate (or separator plate) and riser must be installed as shown in Figure 1 or 2.

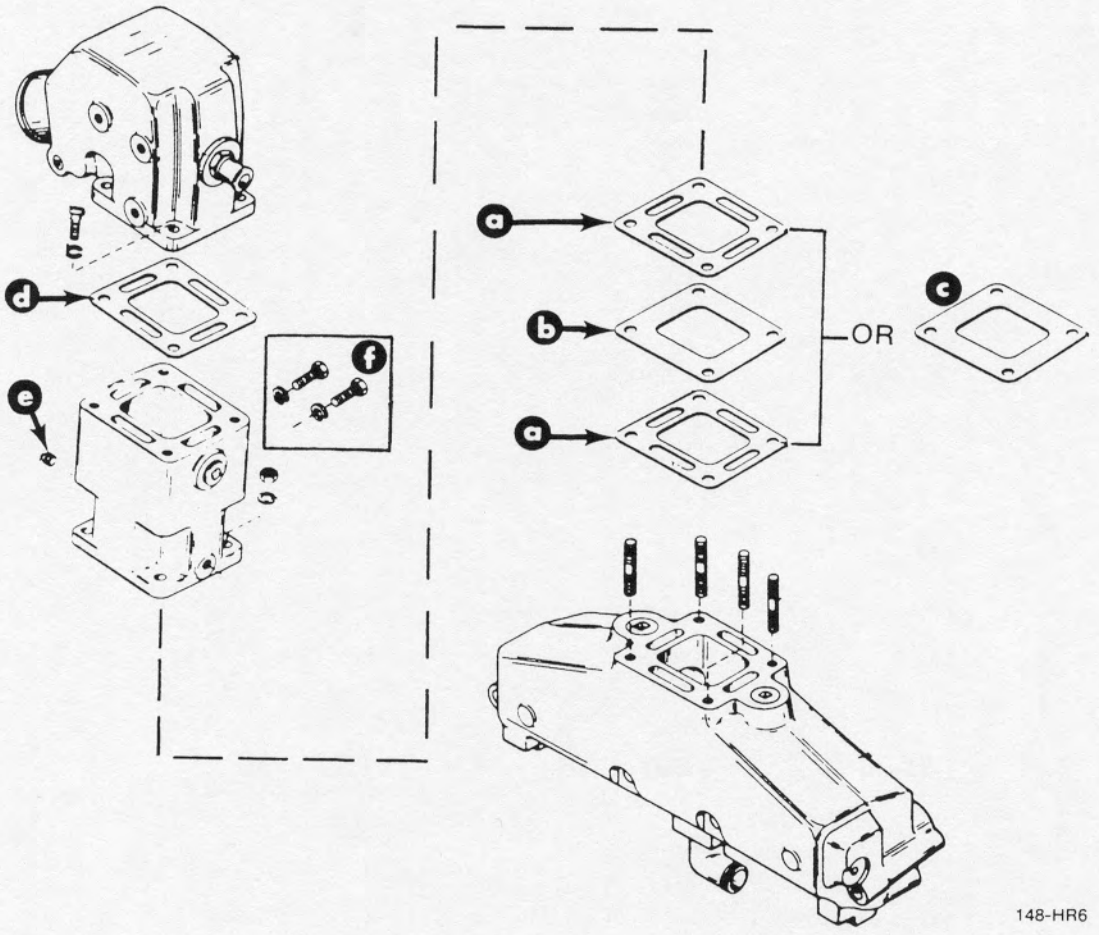
IMPORTANT: If engine is equipped with closed cooling, stainless steel separator plate must be installed below 6" risers. If plate is installed above 6" riser, a steam pocket will form in exhaust manifolds during operation.

6. Torque fasteners to specifications.
7. **Elbow with ignition amplifier:** Reinstall ignition amplifier and wiring harness mounting bracket onto exhaust elbow using original attaching hardware. Be sure to reconnect amplifier and wiring harness ground wires to one of the attaching screws and that amplifier spacers are installed between amplifier and exhaust elbow. Tighten screws securely.
8. **Elbow with shift plate (MCM only):** Reinstall shift plate. Tighten fasteners securely. Readjust shift cables as outlined in "Stern Drive Service Manual".
9. Tighten hose clamps securely.
10. **Closed Cooling System:** Refill closed cooling system.
11. Check for leaks after starting engine.



a - Gasket (27-87105)
b - Stainless Steel Restrictor Plate — or C
c - Restrictor Gasket (27-41813) - DO NOT Use Perfect Seal on Gasket
d - Gasket (27-87105)
e - Drain Plug - Down and Toward Rear of Boat
f - Screw [10-26487, 3/8"-16 x 1-1/8" (29mm)] - Starboard Riser with Wiring Harness Bracket

Figure 1. Engines without Closed Cooling



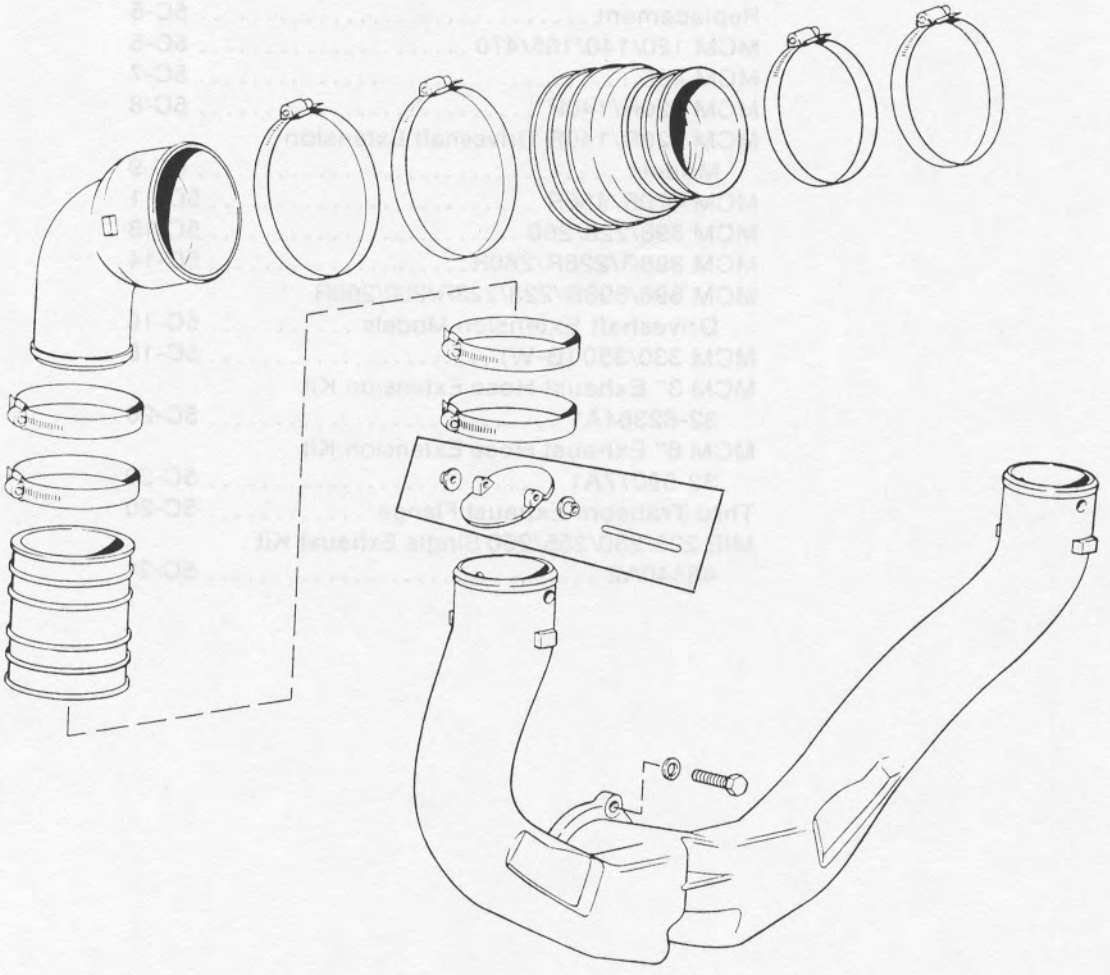
a - Gasket (27-87105) — or C
b - Stainless Steel Separator Plate — or C
c - Separator Gasket (27-41811) - DO NOT Use Perfect Seal on Gasket
d - Gasket (27-87105)
e - Drain Plug - Down and Toward Rear of Boat
f - Screw [10-26487, 3/8"-16 x 1-1/8" (29mm)] - Starboard Riser with Wiring Harness Bracket

Figure 2. Engines with Closed Cooling

OR

SECTION 5 - EXHAUST SYSTEM

PART C - EXHAUST COLLECTORS



MERCURY MARINE
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STERN DRIVES & INBOARDS

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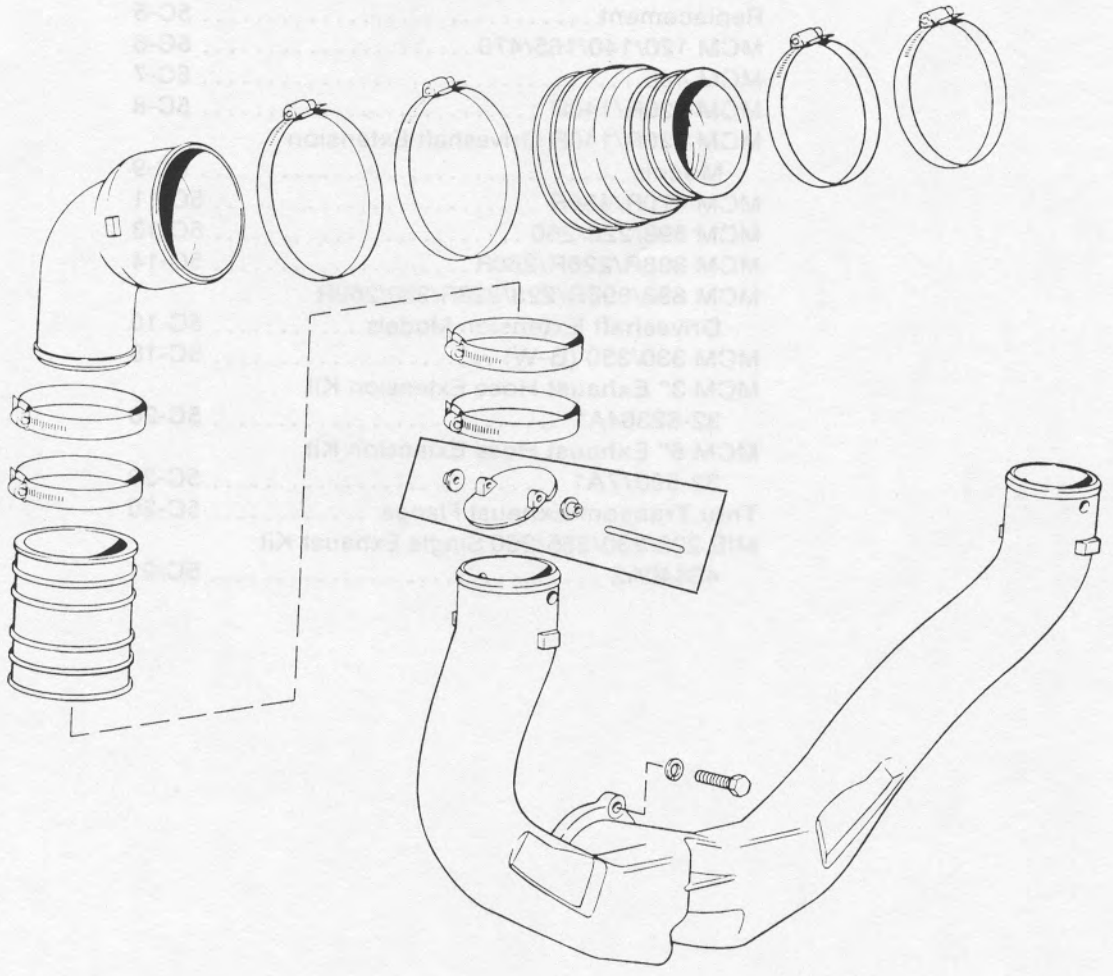
SECTION 5 - EXHAUST SYSTEM

PART C - EXHAUST COLLECTORS



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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Block Off Plate	20-25 (27-34)
Exhaust Pipe to Gimbal Housing	20-25 (27-34)
Exhaust Pipe to Tee Pipe	20-25 (27-34)
Hose Clamps	Securely
Tee Pipe to Gimbal Housing	20-25 (27-34)
Upper Exhaust Pipe to Lower Exhaust Pipe	20-25 (27-34)
Water Shutter Screw/Nut	Securely

SEALANTS

SEALANTS	
92-86166	Quicksilver Bellows Adhesive
92-34227	Quicksilver Perfect Seal

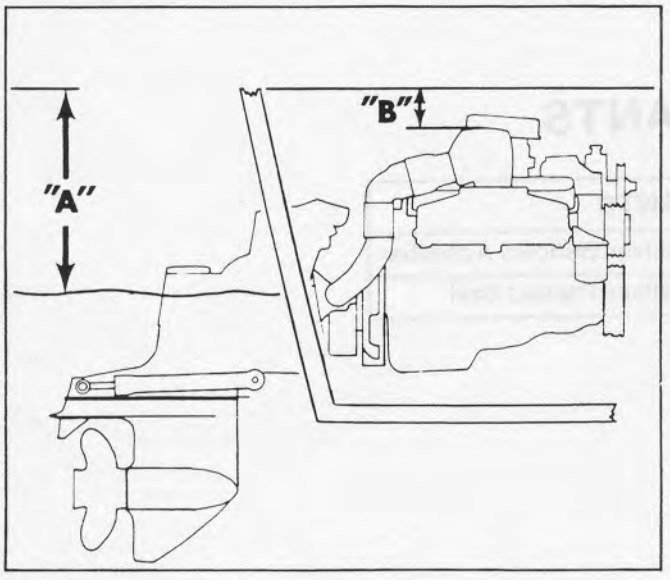
EXHAUST SYSTEM REQUIREMENTS

MCM ENGINES WITH THRU DRIVE UNIT EXHAUST

⚠CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

Determine if exhaust elbow risers are required by taking measurements "A" and "B" in Figure 1, with boat at rest in the water and maximum load aboard. Subtract "B" from "A". If "A" minus "B" is less than specified in chart, select appropriate size exhaust elbow riser kit and exhaust extension kit that will correctly position exhaust elbow.



a - From Waterline to Top of Transom
b - From Highest Point on Exhaust Elbow to Top of Transom

Figure 1. Exhaust Elbow Measurement

Model	"A" Minus "B" Must Be In. (mm) or More
MCM 120	12-1/2 (318) (Note 1)
MCM 120R	11 (279)
MCM 140	12-1/2 (318)
MCM 140R	11 (279)
MCM 165	12-1/2 (318)
MCM 470	12-1/2 (318)
MCM 470R	13 (330) (Note 1)
MCM 485	13 (330) (Note 1)
MCM 488R	13 (330) (Note 1)
MCM 898	12-7/8 (327)
MCM 898R	13 (330)
MCM 228	12-7/8 (327)
MCM 228R	13 (330)
MCM 260	12-7/8 (327)
MCM 260R	13 (330)
MCM 330	15-3/8 (391)
MCM 330 (B-W)	13 (330)

NOTE 1: Exhaust Elbow Riser Kits are not available for this model.

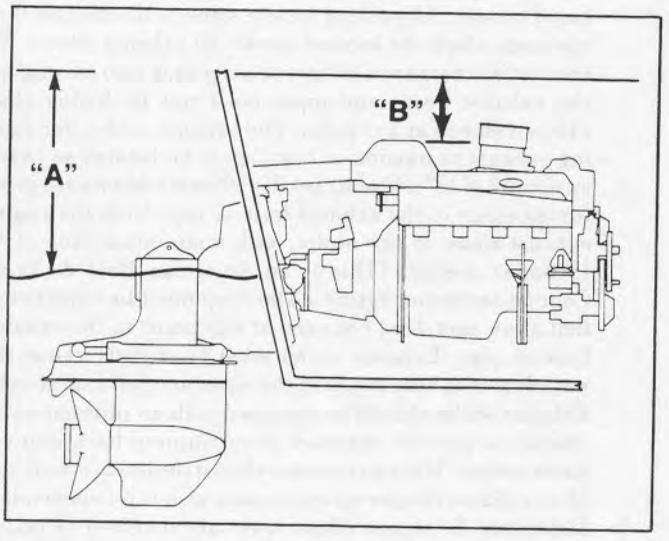
MCM ENGINES WITH THRU TRANSOM EXHAUST

⚠CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

Determine if exhaust elbow risers are required by taking measurements "A" and "B" in Figure 2, with boat at rest in the water and maximum load aboard. Subtract "B" from "A". If "A" minus "B" is less than specified in chart, select appropriate size exhaust elbow riser kit that will correctly position exhaust elbows. Also, a ½" (13mm) per foot (305mm) downward drop must exist in the exhaust hose from the engine exhaust elbow to the transom outlet. Exhaust hoses must not restrict discharge water flow at exhaust elbow. (Figure 3) Transom outlet should have internal water shutters and outlet covers ("Flappers") on outside.

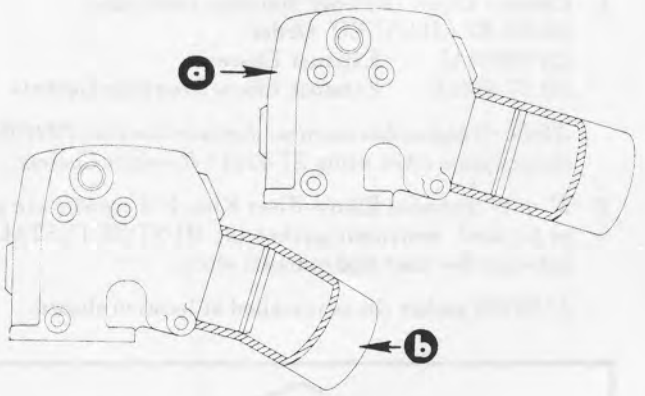
IMPORTANT: For MCM 120-330 (B-W) engines, also refer to "MCM 120-330 (B-W) Engines", following.



a - From Waterline to Top of Transom
b - From Highest Point on Exhaust Elbow to Top of Transom

Figure 2. Exhaust Elbow Measurement

Model	"A" Minus "B" Must Be In. (mm) or More
MCM 370/400/ 400 Cyclone	15 (381mm)



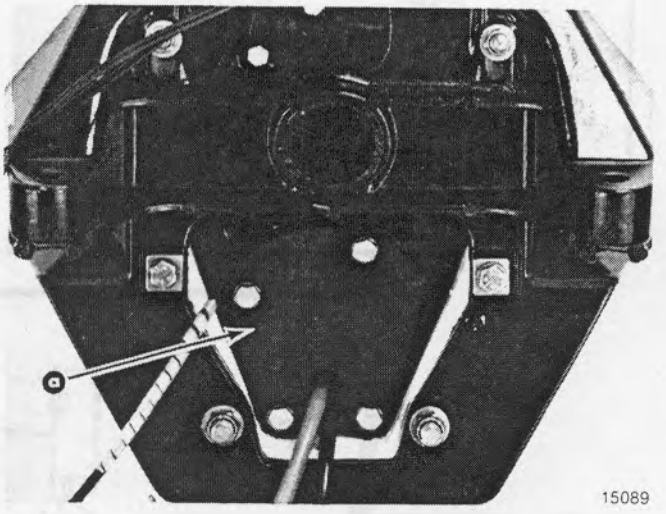
a - Correct b - Incorrect

Figure 3. Hose Connection

MCM 120-330 (B-W) Engines

There are no kits to convert these engine from thru drive to thru transom exhaust. By using block off plates, inboard exhaust elbows, exhaust hoses and transom outlet fittings, many engines have been converted to thru transom exhaust. In addition to the preceding information, the following should be adhered to:

- "Exhaust Elbow Measurement" must be checked. (Figure 1)
- Block of plates (for drive exhaust system) must be able to prevent water from entering the boat.
- Exhaust bellows (between gimbal housing and bell housing) should be removed to allow propeller to draw air.
- MCM 120R-260R Engines Only: Refer to Figure 4.
- MCM 898R/228R/260R Engine Only: Refer to Figure 5.



a - Block Off Plate P/N 97350

Figure 4. MCM 120R-260R Only

1. Exhaust Elbow (without stainless steel tube): MUST BE CHANGED. Order:
   (2) 98504A3 Exhaust Elbows
   (2) 27-41813 Exhaust Elbow Restrictor Gaskets

   NOTE: If engine has stainless steel restrictor plate (99208A1), discard plate when using 27-41813 Restrictor Gaskets.

2. 3″ or 6″ Exhaust Elbow Riser Kits: If these kits are going to be used, restrictor gasket (a) MUST BE INSTALLED between the riser and exhaust elbow.

   27-87105 gasket (b) is installed at location shown.

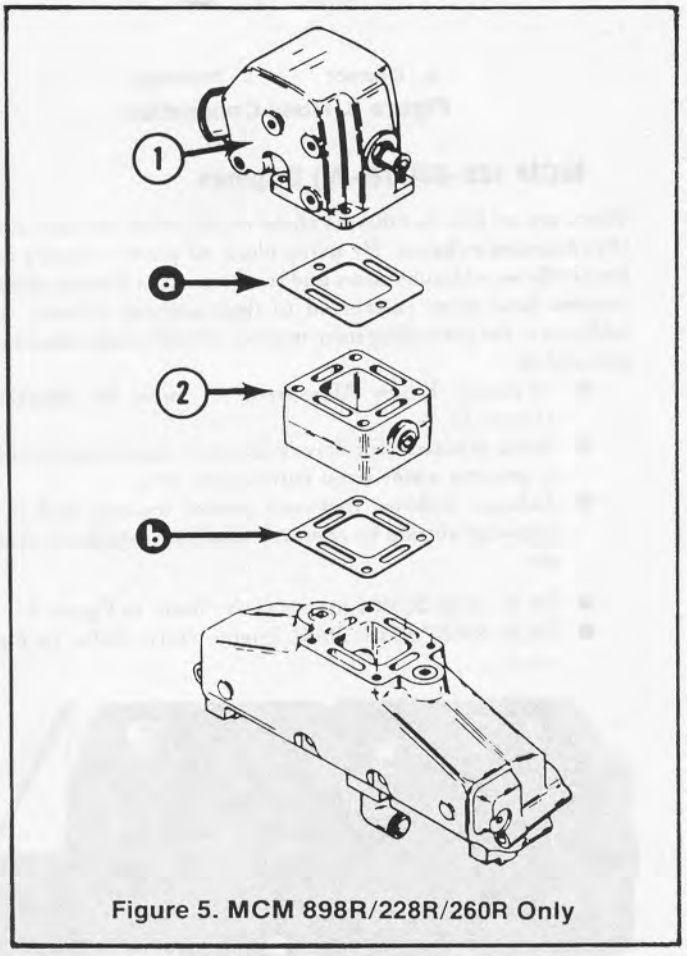
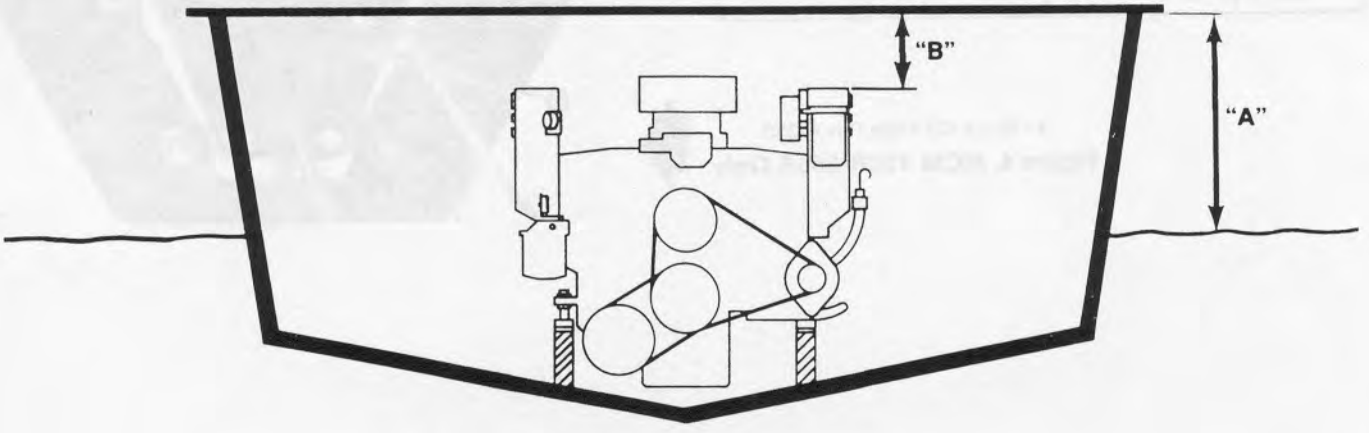


Figure 5. MCM 898R/228R/260R Only

⚠CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

1. System layout and construction must prevent cooling system discharge water from flowing back into engine and also must prevent seawater from entering engine via exhaust system. All cooling system water is discharged thru openings which are located inside the exhaust elbows. To prevent discharge water from flowing back into the engine, the exhaust hoses and pipes must not be higher than exhaust elbows at any point. The exhaust outlet (for routing exhaust to outside of boat) must be located so that a minimum of ½″ (13mm) per 1′ (305mm) downward pitch (drop) exists in the exhaust hose or pipe from the engine exhaust elbow to the outlet, with a minimum drop of 4″ (100mm) overall. (This is an American Boat & Yacht Council recommendation.) The drop must be constant so that a low spot does not exist at any point in the exhaust hose or pipe. Exhaust outlet must be slightly above the waterline with boat at rest in the water and full load aboard. Exhaust outlet should be equipped with an internal water shutter to prevent seawater from running back into exhaust system. If thru-transom exhaust outlets are used, use of an exhaust flapper on each outlet also is recommended.
2. Determine if exhaust elbow risers are required by taking measurements "A" and "B" in Figure 6, with boat at rest in the water and maximum load aboard. Subtract "B" from "A". If "A" minus "B" is less than specified in chart, select appropriate size exhaust elbow riser kit that will correctly position exhaust elbows.



a - From Waterline to Reference Point
b - From Highest Point on Exhaust Elbow to Same Reference Point

Figure 6. Exhaust Elbow Measurement

Model	"A" Minus "B" Must Be In. (mm) or More
MIE 470	14 (356)
MIE 228	14 (356) (Note 1)
MIE 230	13 (330)
MIE 255	14 (356) (Note 1)
MIE 260	13 (330)
MIE 330	14 (356)
MIE 340	13 (330)

NOTE 1: V-Drive Models; 16" (406mm)

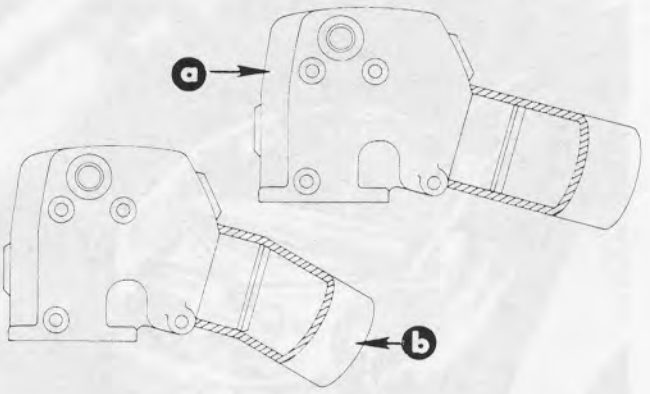
3. System must not cause excessive back pressure. Back pressure MUST NOT exceed 4" (100mm) of mercury when measured with a mercury manometer at exhaust elbow outlets. Minimum exhaust hose sizes are given in charts.

MIE 470 MINIMUM EXHAUST HOSE SIZE	
Single Exhaust	3" (76mm)

MIE 228/230/255/260 MINIMUM EXHAUST HOSE SIZES	
Dual Exhaust	3" (76mm)
Single Exhaust	4" (102mm)

MIE 330/340 MINIMUM EXHAUST HOSE SIZES	
Dual Exhaust	3" (76mm)
Single Exhaust	5" (127mm)

4. Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from the elbow. (Figure 7) If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn thru.



a - Correct
b - Incorrect

Figure 7. Hose Connection

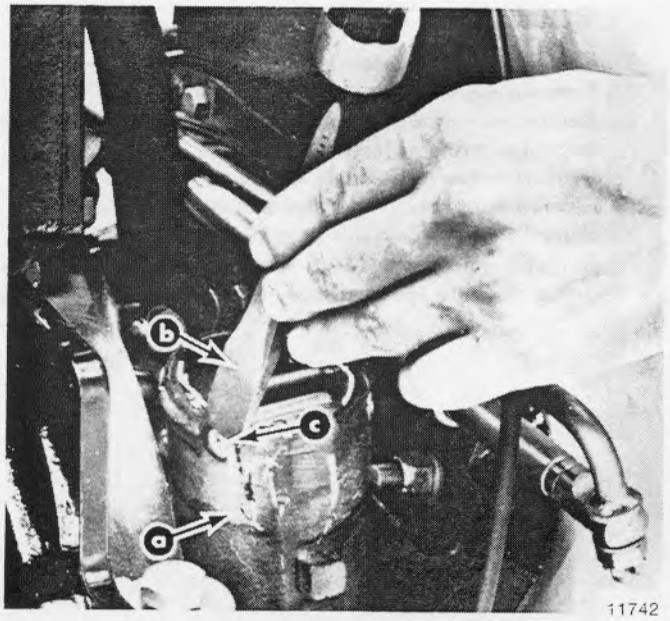
EXHAUST COMPONENT and SHUTTER REPLACEMENT

MCM 120/140/165/470

Shutter Replacement

IMPORTANT: Engine does not have to be removed to replace shutters, however, exhaust elbow may have to be removed to remove exhaust bellows.

1. Loosen hose clamps on exhaust bellows and remove bellows.
2. Chisel rivets away from one (most easily accessible) support member and remove support member. (Figure 1)



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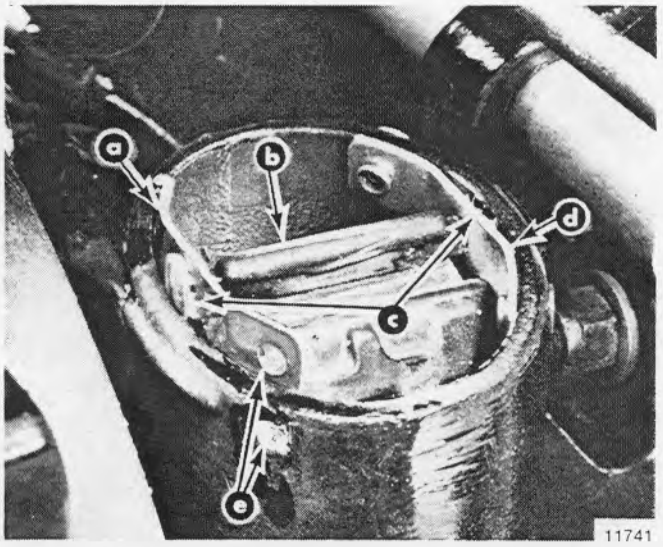
a - Exhaust Elbow
b - Chisel
c - Rivet

Figure 1. Removing Shutter

3. Apply silicone sealer to one end of new shutter, then place end in support member that was removed in Step 2.
4. Bend tongues of shutter away from center support bar and point them down exhaust elbow. Place other end of shutter (after applying silicone to end) in support member (still in exhaust pipe), while positioning shutter assembly so that mounting holes line up. (Figure 2)
5. Secure support member with 10-32 x ½" (13mm) round head screws and nuts. Be sure that head of screw is to the outside of exhaust elbow.
6. Place hose clamps over both ends of exhaust bellows, then reposition between engine and exhaust pipe and tighten hose clamps.

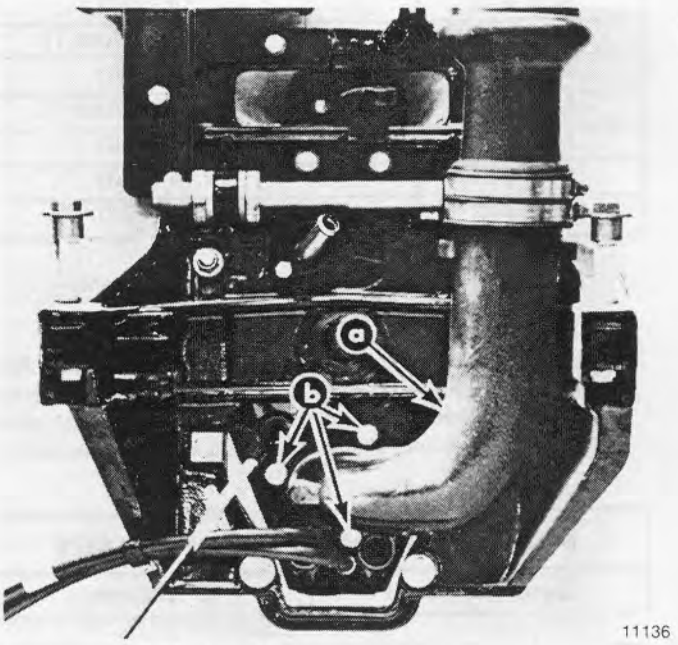


a - Support Member Removed in Disassembly
b - Shutter - Opens Downward
c - Silicone Sealer
d - Support Member
e - Align These Holes

Figure 2. Replacing Shutter

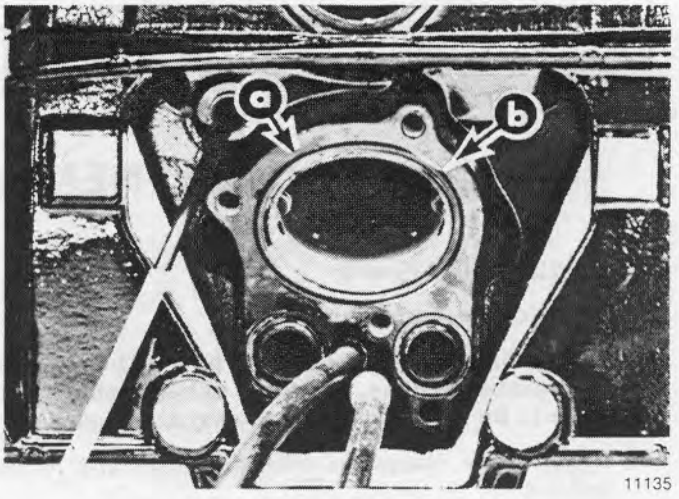
Exhaust Pipe Replacement

1. Remove stern drive unit.
2. Remove engine.
3. Remove screws and lockwashers that secure exhaust pipe to gimbal housing. (Figure 3)
4. Remove exhaust pipe and "O" ring.
5. Clean mating surfaces on pipe and gimbal housing.
6. Place "O" ring in groove of gimbal housing. (Figure 4)
7. Reinstall exhaust pipe with screws and lockwashers, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage. (Figures 3 and 4)
8. Reinstall engine and stern drive unit.



a - Exhaust Pipe
b - Screws

Figure 3. Exhaust Pipe



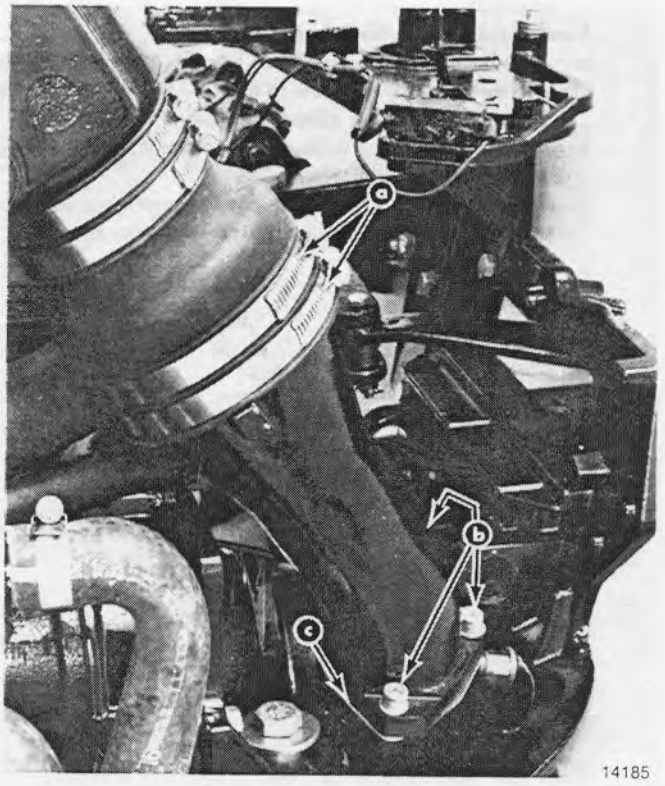
a - Mating Surface
b - "O" Ring in Groove

Figure 4. Exhaust Pipe Mounting Surface

Upper Exhaust Pipe and Shutter Replacement

IMPORTANT: Engine does not have to be removed.

1. Remove screws and loosen exhaust bellows clamps. (Figure 1)



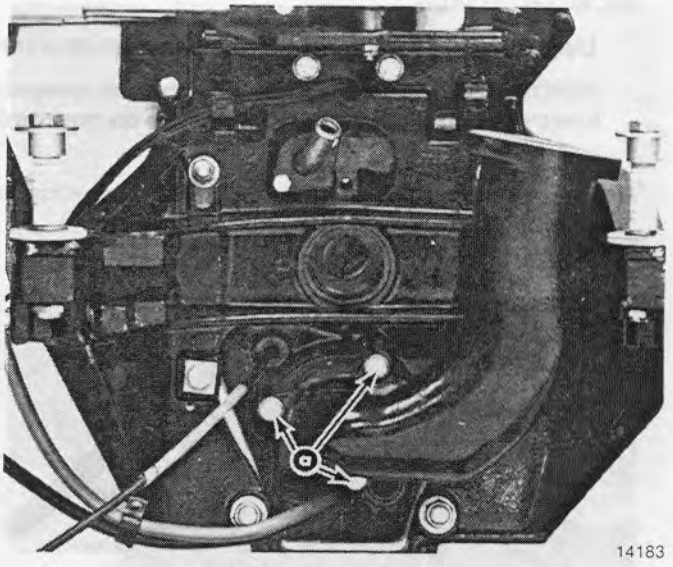
a - Clamps
b - Screws and Washers (3)
c - Gasket

Figure 1. Upper Exhaust Pipe and Bellows

2. Replace shutters as outlined in steps 2, 3, 4 and 5 of "Shutter Replacement, MCM 120/140/165/470".
3. Using new gasket, place clamps over exhaust bellows, then install upper exhaust pipe. (Figure 1)
4. Torque screws to specification. Tighten clamps securely.

Exhaust Pipe Replacement

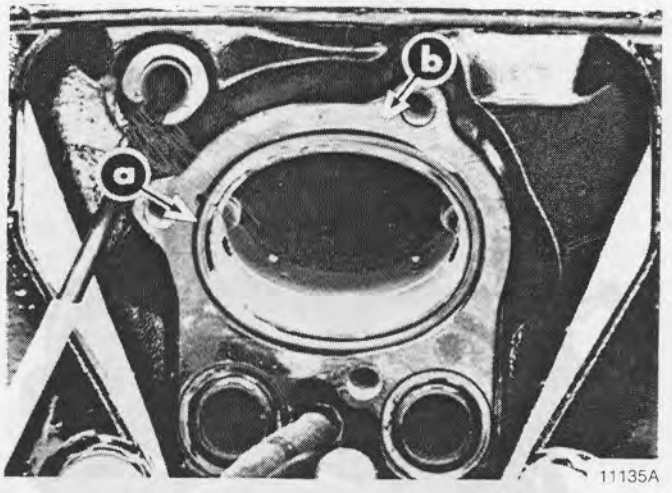
1. Remove stern drive unit.
2. Remove upper exhaust pipe, then engine.
3. Remove screws and lockwashers that secure lower exhaust pipe to gimbal housing. (Figure 2)



a - Screws and Lockwashers

Figure 2. Lower Exhaust Pipe

4. Remove exhaust pipe and "O" ring.
5. Clean mating surfaces on pipe and gimbal housing.
6. Place "O" ring in groove of gimbal housing. (Figure 3)
7. Reinstall lower exhaust pipe with screws and lockwasher, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
8. Reinstall engine and stern drive unit.
9. Reinstall upper exhaust pipe.



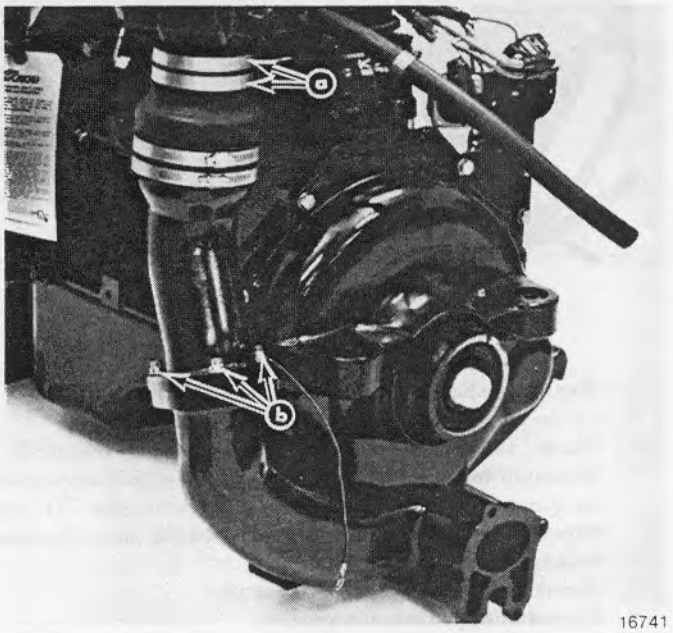
a - "O" Ring in Groove b - Mating Surface

Figure 3. Exhaust Pipe Mounting Surface

Upper Exhaust Pipe and Shutter Replacement

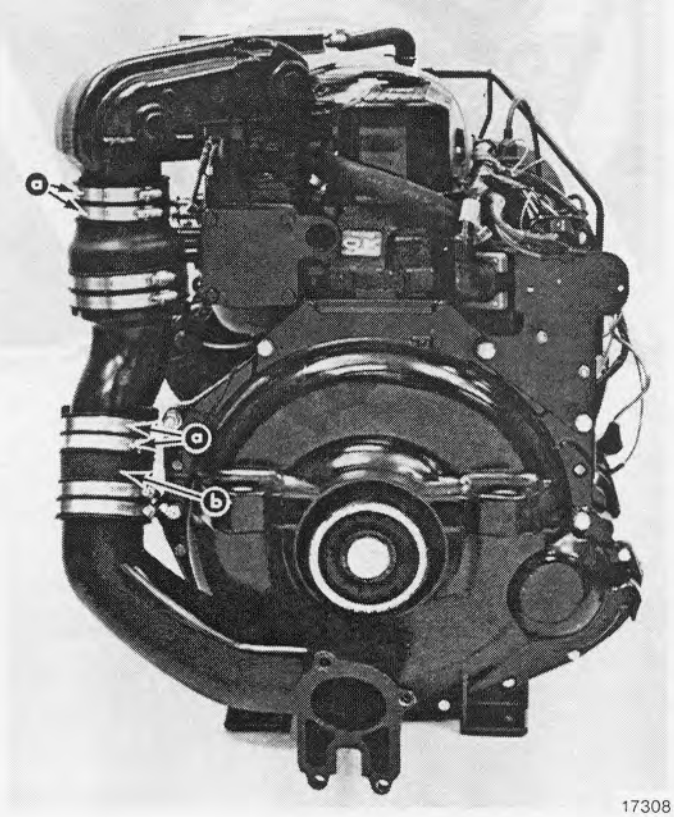
IMPORTANT: Engine does not have to be removed, however, exhaust elbow may have to be removed.

1. Loosen exhaust bellows clamps.
2. Remove screws and lockwashers (Figure 1) or hose clamps. (Figure 2)
3. Remove upper exhaust pipe.



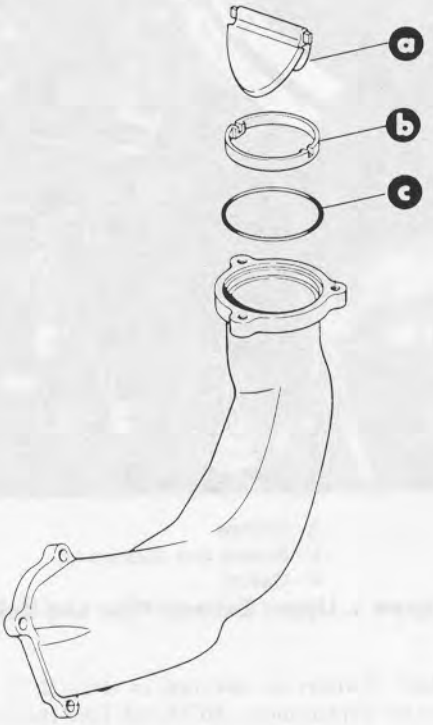
a - Clamps
b - Screws and Lockwashers (3)

Figure 1. Flanged Connection



4. Replace shutter (in lower pipe), as shown in Figure 3 or 4.
5. **Flange Connection Models (Figure 3):**
   a. Make sure "O" ring is in groove.
   b. Place clamps over exhaust bellows, then install upper exhaust pipe. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
   c. Torque screws to specifications. Tighten clamps securely.

   Connector Hose Models (Figure 4):
   a. Coat both mating surfaces of hose and lower pipe with Bellows Adhesive. Allow to dry and then slide hose on lower pipe. Tighten clamps securely.
   b. Place clamps over bellows and connector hose, then install upper exhaust pipe.
   c. Making sure all clamps are contacting exhaust elbow, upper pipe and lower pipe, tighten clamps securely.

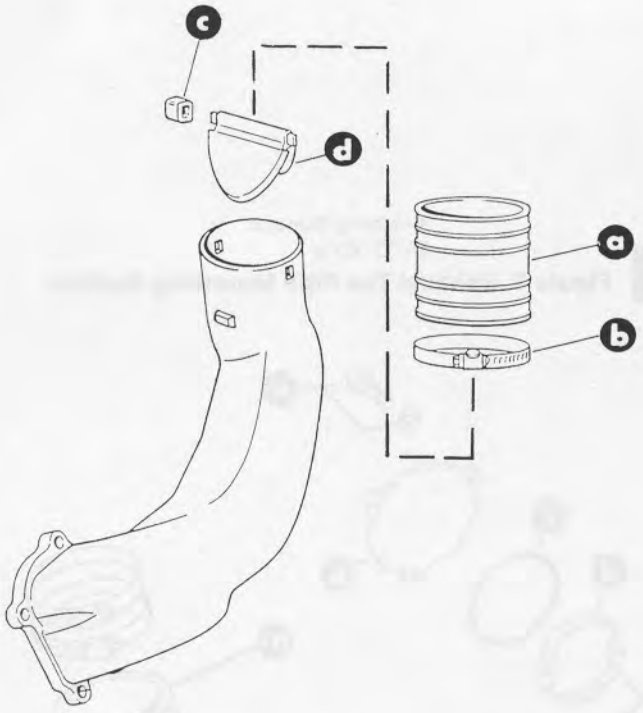


a - Shutter - Opens Downward
b - Retainer - Slots Up
c - "O" Ring - In Groove of Lower Pipe

Figure 3. Flanged Connection

a - Clamps
b - Connector Hose

Figure 2. Connector Hose Connection

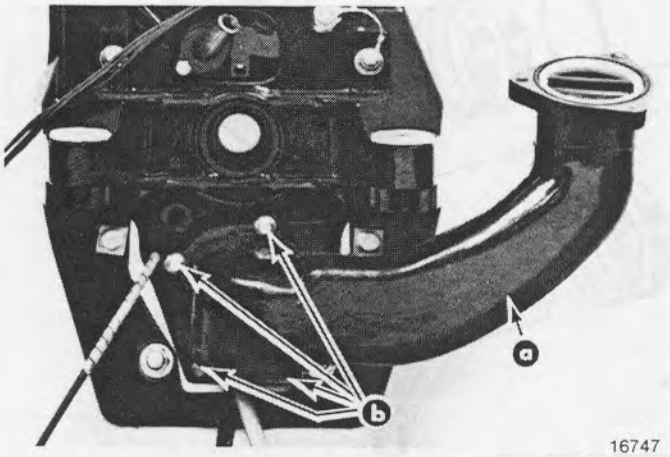


a - Connector Hose - Remove to Change Shutters
b - Clamps (2)
c - Grommet (2)
d - Shutter - Opens Downward

Figure 4. Connector Hose Connection

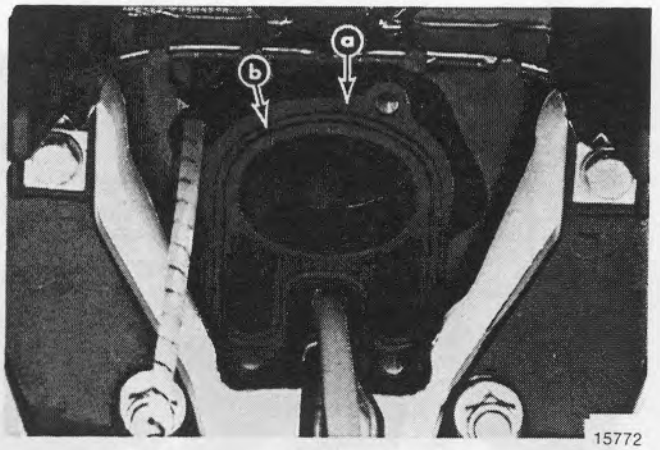
Lower Exhaust Pipe Replacement

1. Remove stern drive unit.
2. Remove engine, then upper exhaust pipe.
3. Remove screws and lockwashers that secure lower exhaust pipe to gimbal housing. (Figure 5)



a - Lower Exhaust Pipe
b - Screws and Lockwashers (4)

Figure 5. Lower Exhaust Pipe



a - Mating Surface
b - "O" Ring

Figure 6. Exhaust Pipe Mounting Surface

4. Remove exhaust pipe and "O" ring.
5. Clean mating surfaces on pipe and gimbal housing.
6. Place "O" ring in groove of gimbal housing. (Figure 6)
7. Reinstall lower exhaust pipe with screws and lockwashers, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
8. Reinstall upper exhaust pipe, then engine.
9. Reinstall stern drive unit.

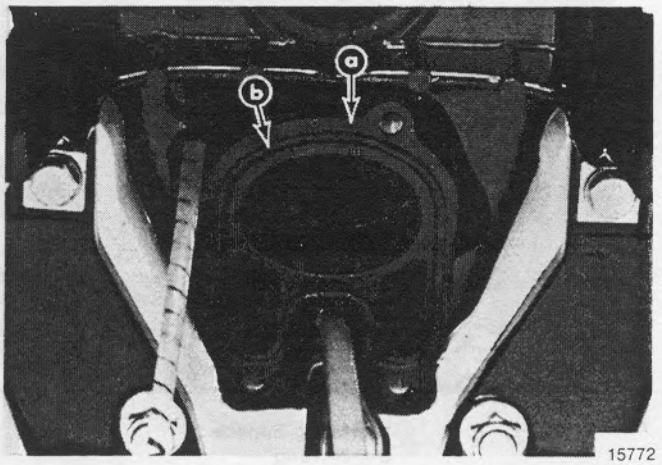
MCM 120R/140R DRIVESHAFT EXTENSION MODELS

Shutter Replacement

1. Loosen hose clamps on exhaust hose and remove screws and lockwashers. (Figure 2)
2. Remove exhaust pipe elbow.
3. Remove water shutter, then retainer from tee pipe.
4. Install retainer, then shutter as shown in Figure 2.
5. Make sure mating surfaces are clean and "O" ring is in groove.
6. Reinstall exhaust pipe elbow with screws and lockwashers, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
7. Tighten clamps securely.

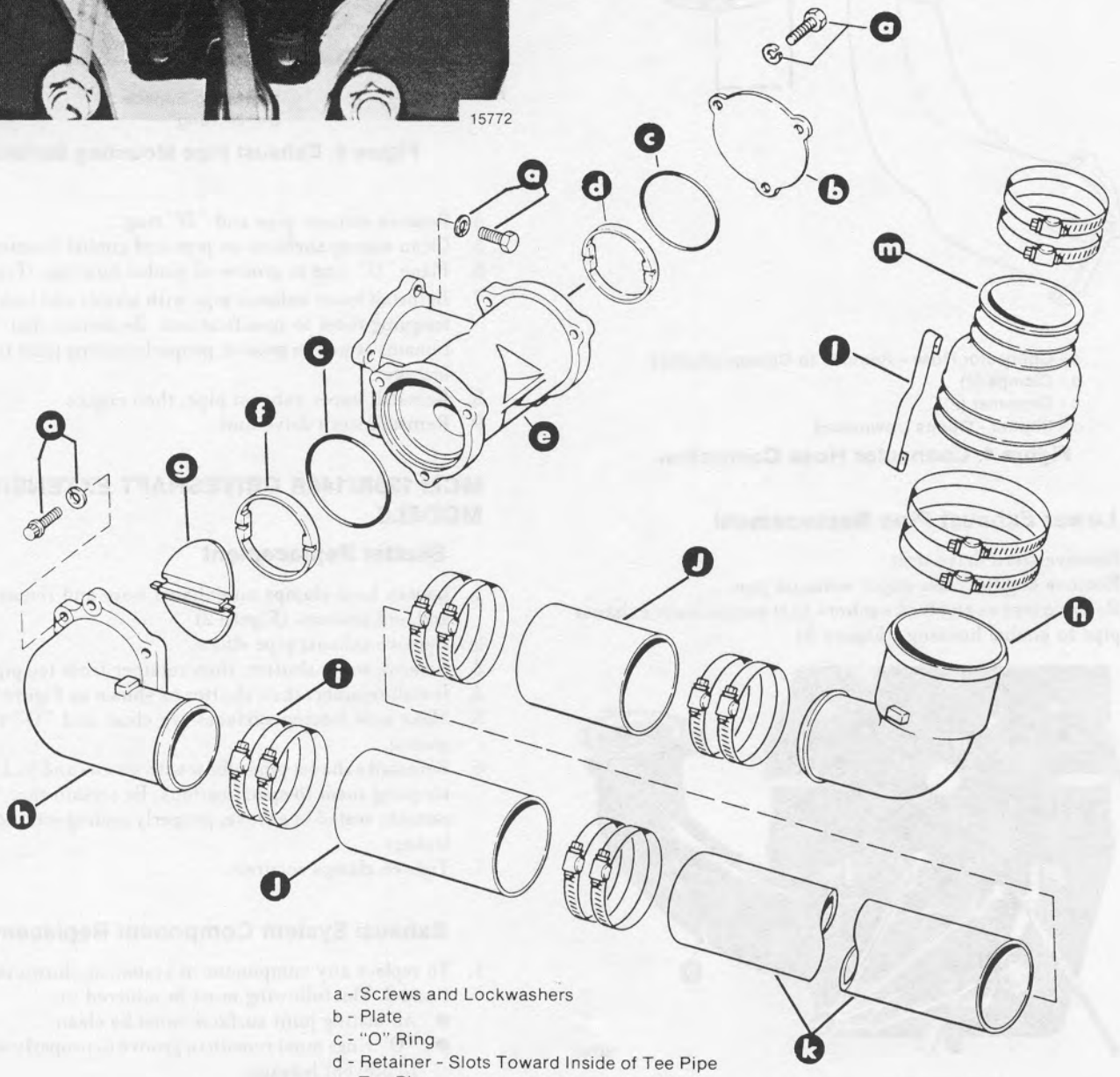
Exhaust System Component Replacement

1. To replace any component in system as shown in Figures 1 and 2. The following must be adhered to:
   - All mating joint surfaces must be clean.
   - "O" rings must remain in groove to properly seal joints to prevent leakage.
   - Torque all screws and lockwashers to specifications.
   - Tighten all clamps securely.



a - Mating Surface
b - "O" Ring

Figure 1. Exhaust Tee Pipe Mounting Surface



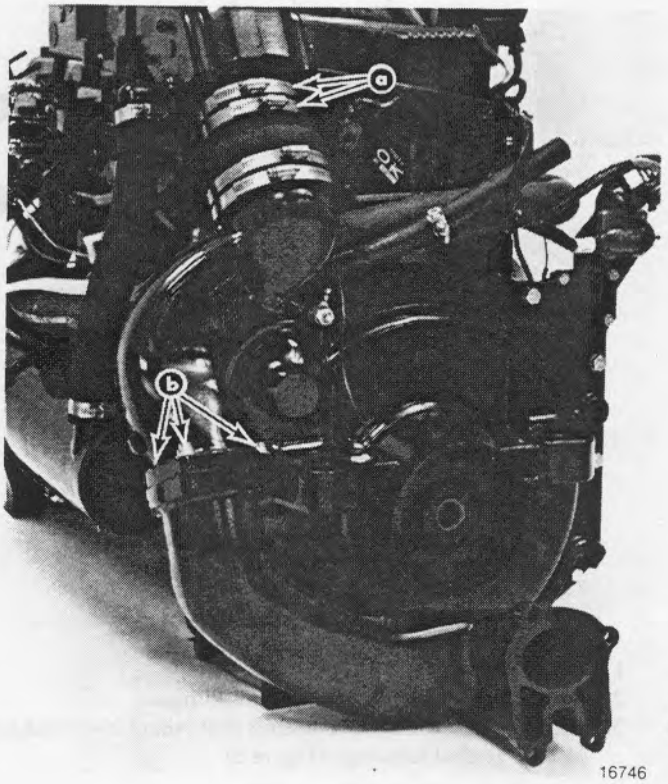
a - Screws and Lockwashers
b - Plate
c - "O" Ring
d - Retainer - Slots Toward Inside of Tee Pipe
e - Tee Pipe
f - Retainer - Slots Facing Toward Outside of Tee Pipe
g - Water Shutter - Opens Toward Inside of Tee Pipe
h - Exhaust Pipe Elbow
i - Clamps
j - Exhaust Hose
k - Exhaust Tube
l - Ground Strap
m - Exhaust Bellows

Figure 2. Exhaust System Components

Upper Exhaust Pipe and Shutter Replacement

IMPORTANT: Engine does not have to be removed, however, exhaust elbow may have to be removed.

1. Loosen exhaust bellows clamps.
2. Remove screws and lockwashers (Figure 1) or hose clamps. (Figure 2)
3. Remove upper exhaust pipe.



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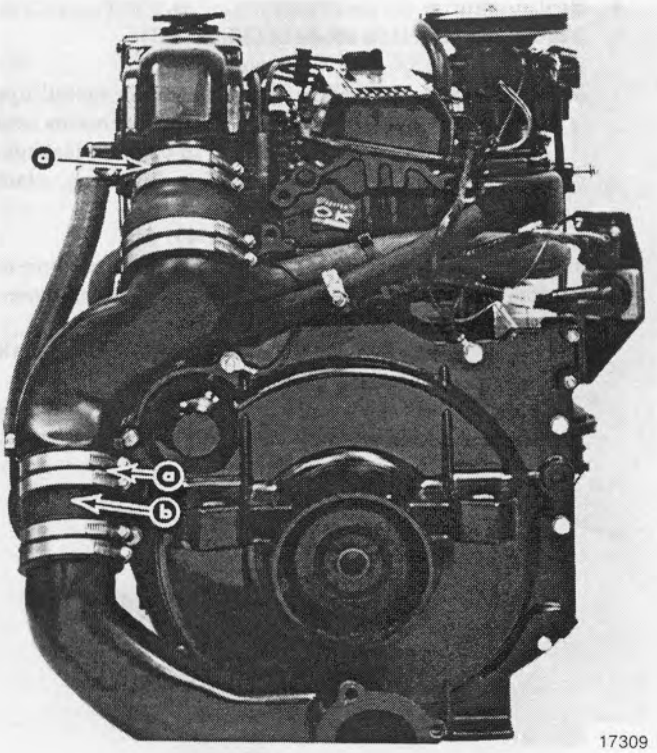
a - Clamps
b - Screws and Lockwashers (3)

Figure 1. Flanged Connection



17309

a - Clamps
b - Connector Hose

Figure 2. Connector Hose Connection

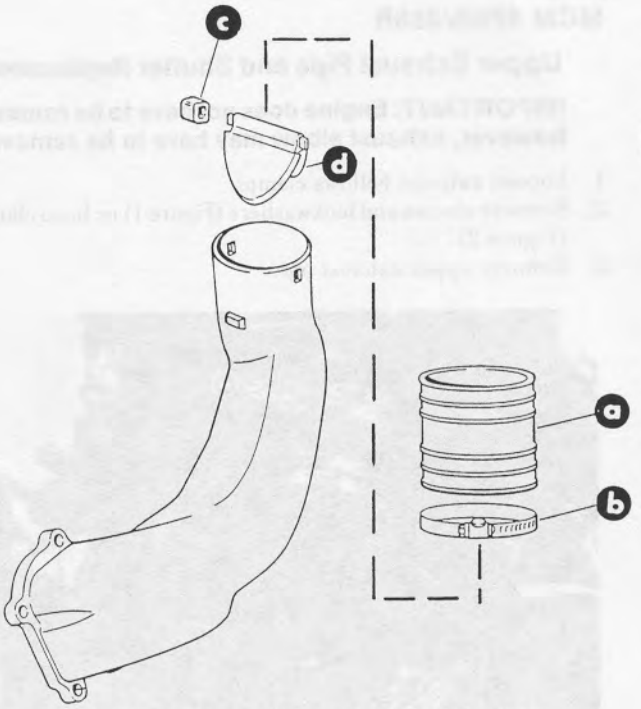
4. Replace shutter (in lower pipe), as shown in Figure 3 or 4.
5. **Flange Connection Models (Figure 3):**
   a. Make sure "O" ring is in groove.
   b. Place clamps over exhaust bellows, then install upper exhaust pipe. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
   c. Torque screws to specification. Tighten clamps securely.

Connector Hose Models (Figure 4):

a. Coat both mating surfaces of hose and lower pipe with Bellows Adhesive. Allow to dry and then slide hose on lower pipe. Tighten clamps securely.
b. Place clamps over bellows and connector hose, then install upper exhaust pipe.
c. Making sure all clamps are contacting exhaust elbow, upper pipe and lower pipe, tighten clamps securely.

a - Shutter - Opens Downward
b - Retainer - Slots Up
c - "O" Ring - In Groove of Lower Pipe

Figure 3. Flanged Connection

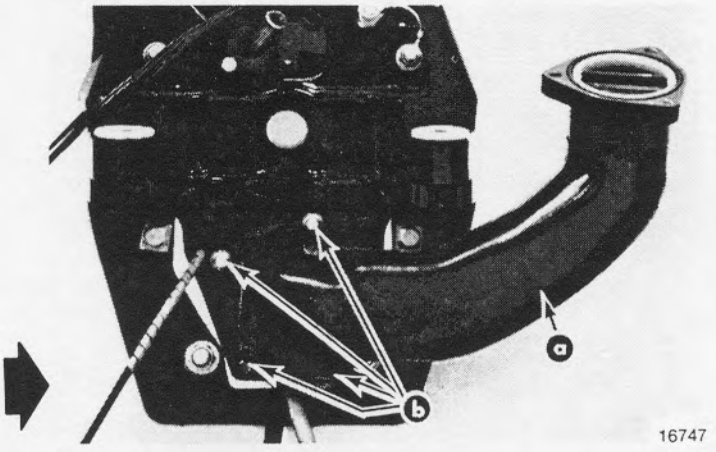


a - Connector Hose - Remove to Change Shutters
b - Clamps (2)
c - Grommet (2)
d - Shutter - Opens Downward

Figure 4. Connector Hose Connection

Lower Exhaust Pipe Replacement

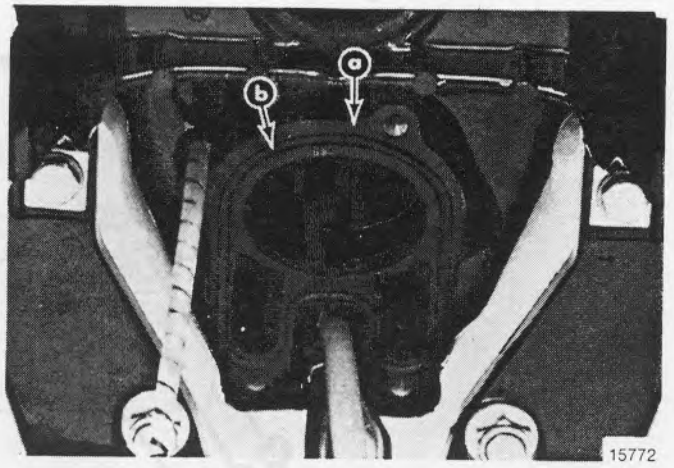
1. Remove stern drive unit.
2. Remove engine, then upper exhaust pipe.
3. Remove screws and lockwashers that secure lower exhaust pipe to gimbal housing. (Figure 5)



a - Lower Exhaust Pipe
b - Screws and Lockwashers (4)

Figure 5. Lower Exhaust Pipe

4. Remove exhaust pipe and "O" ring.
5. Clean mating surfaces on pipe and gimbal housing.
6. Place "O" ring in groove of gimbal housing. (Figure 6)



a - Mating Surface
b - "O" Ring

Figure 6. Exhaust Pipe Mounting Surface

7. Reinstall lower exhaust pipe with screws and lockwashers, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
8. Reinstall engine, then upper exhaust pipe.
9. Reinstall stern drive unit.

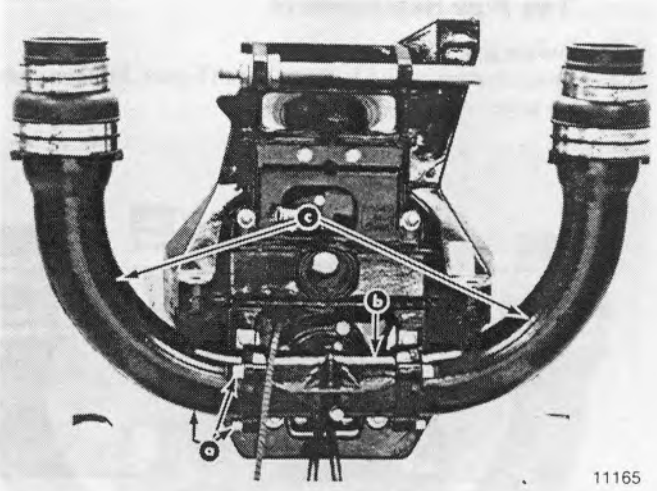
MCM 898/228/260

Exhaust Pipe and Shutter Replacement

IMPORTANT: If a long allen wrench is available, and limits of engine compartment allow access to exhaust pipe allen screws, then removal of stern drive unit and engine is not necessary. Only bellows clamps have to be loosened.

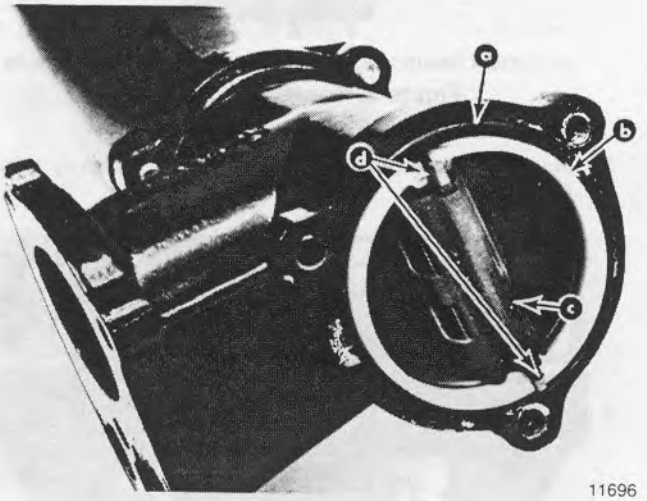
1. Remove stern drive unit.
2. Remove engine.
3. Remove exhaust pipe from tee pipe by removing 3 allen screws and lockwashers. (Figure 1)
4. Replace water shutter as shown in Figure 2.

IMPORTANT: If engine has closed cooling water distribution blocks between exhaust manifold and exhaust elbow, exhaust bellows [P/N 72408, 6-7/64" (155mm) long] must be used on engine.



a - Screws - 3 Each Side
b - Tee Pipe
c - Exhaust Pipe

Figure 1. Exhaust Pipe Removal



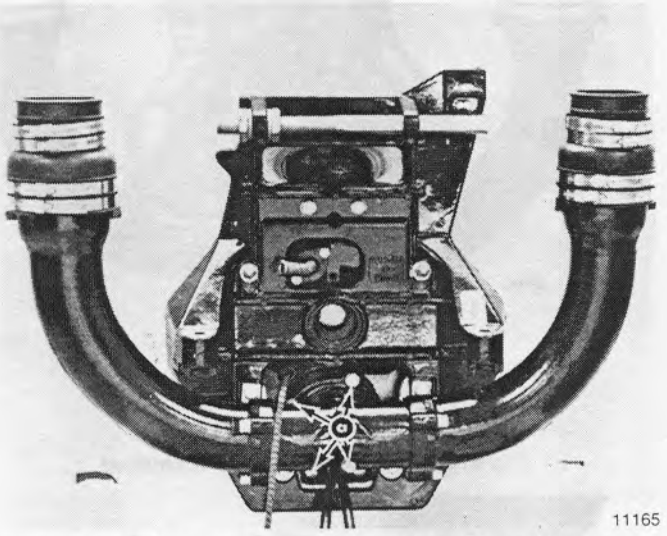
a - "O" Ring
b - Retainer - Installed First
c - Shutter - Opens Toward Tee Pipe
d - Slot (Facing Out)

Figure 2. Replacing Shutter

5. Make sure "O" ring is in groove and mating surfaces are clean.
6. Install exhaust pipe. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
7. Torque screws to specifications.
8. Reinstall engine. Tighten all clamps securely.
9. Reinstall stern drive unit.

Tee Pipe Replacement

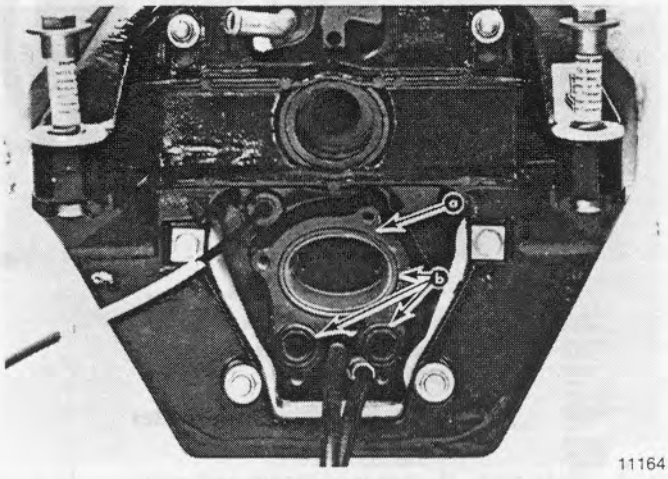
1. Follow preceding instructions.
2. Remove screws and lockwashers (Figure 3), then remove tee pipe.



a - Screws Securing Exhaust Assembly to Gimbal Housing

Figure 3. Removing Tee Pipe

3. Mating surfaces must be clean and "O" rings in grooves. (Figure 4)



a - Mating Surface
b - "O" Rings

Figure 4. Mounting Surface

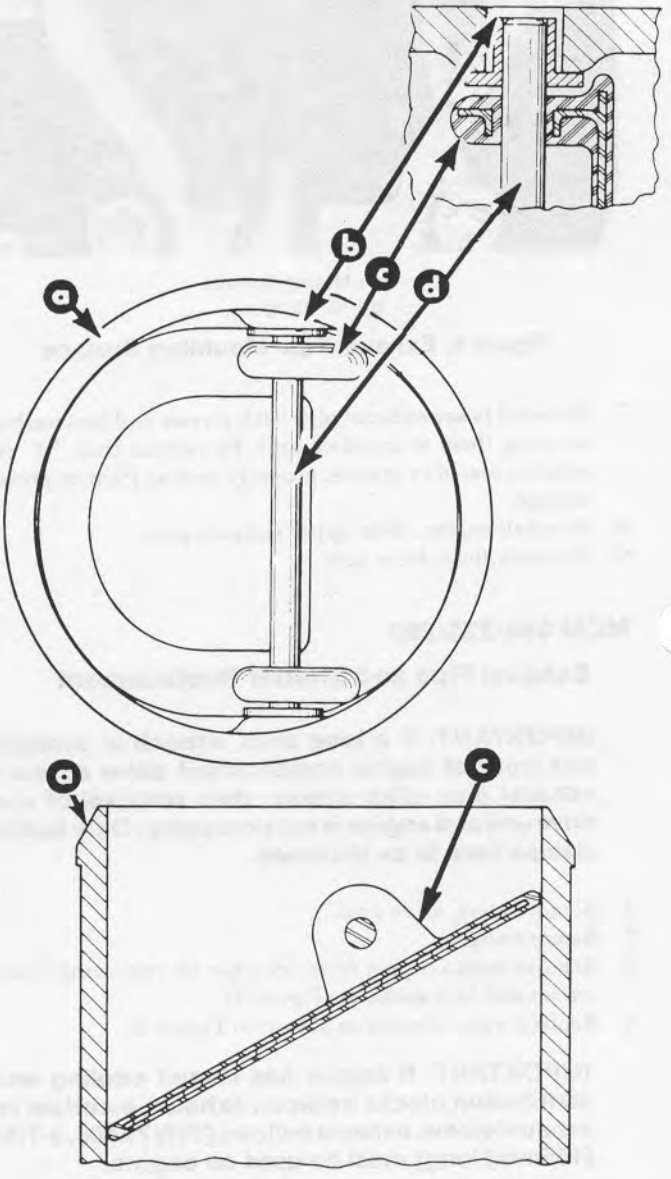
4. Install tee pipe to gimbal housing. Be certain that "O" rings remain seated in grooves, properly sealing joint to prevent leakage.
5. Torque screws to specifications.
6. Follow instruction as outlined in "Exhaust Pipe and Shutter Replacement".

MCM 898R/228R/260R

Shutter Replacement

IMPORTANT: Engine does not have to be removed to change shutters.

1. Loosen clamps and remove exhaust pipe elbow and exhaust hose. (Figure 3)
2. Replace water shutter as shown in Figure 1.
3. Reinstall pipe elbow and hose. Tighten clamps securely.

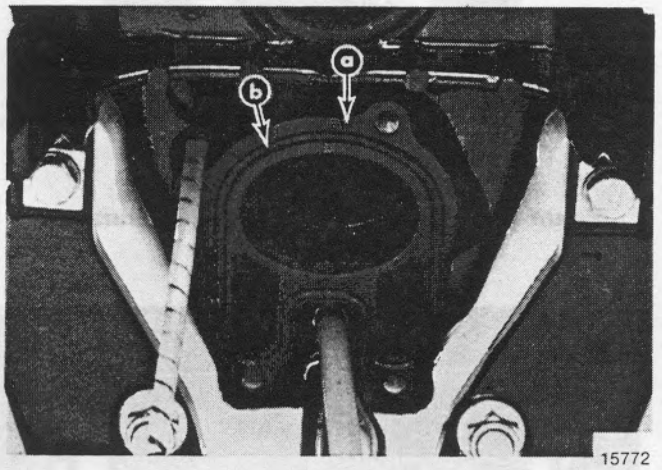


a - Top of Pipe
b - Shoulder Bushing
c - Water Shutter - Install as Shown
d - Shaft

Figure 1. Shutter Replacement

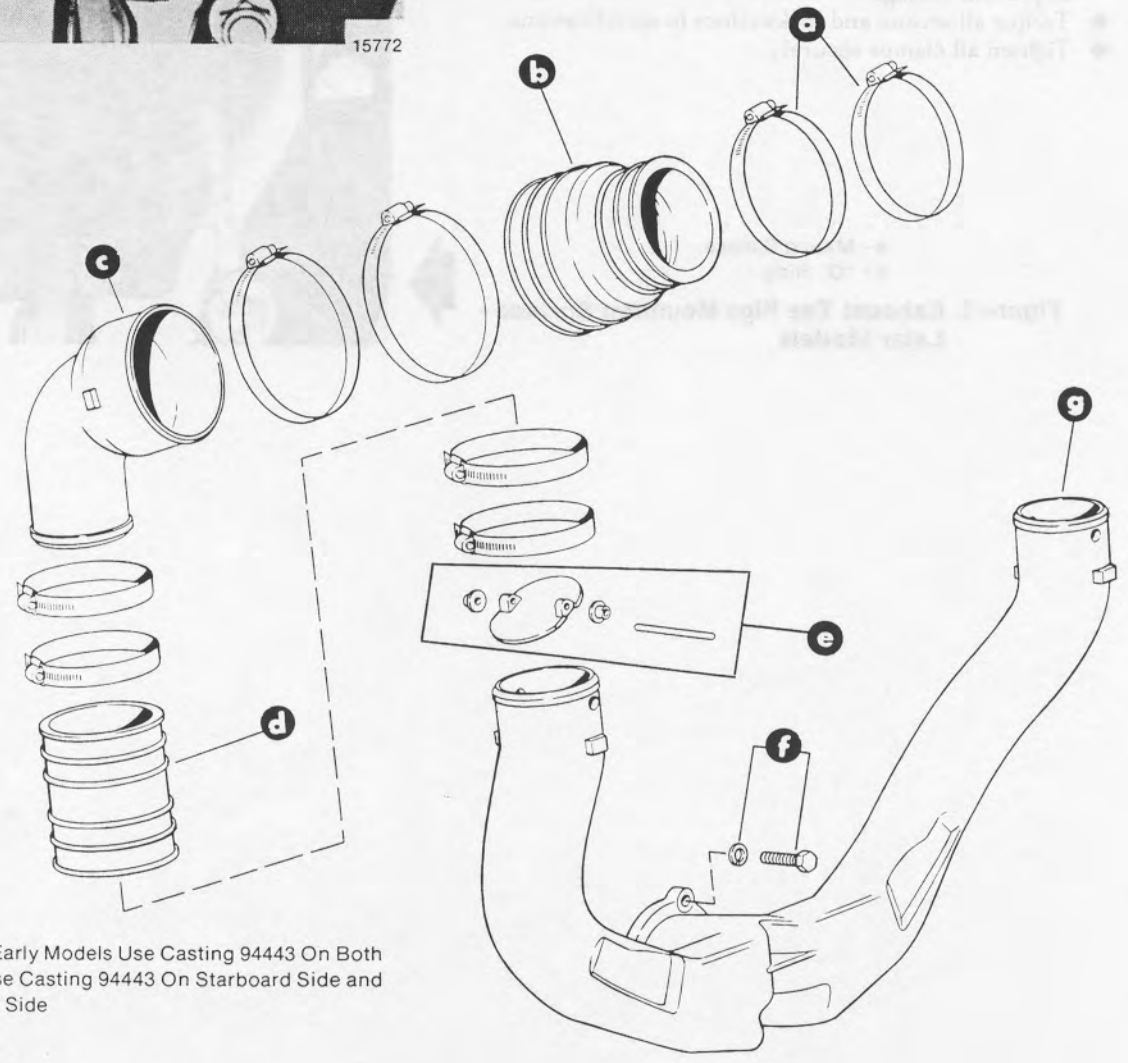
Exhaust System Component Replacement

1. To replace any component in system as shown in Figures 2 and 3. The following must be adhered to:
   - All mating joint surfaces must be clean.
   - "O" ring must remain in groove to properly seal joint to prevent leakage.
   - Torque all screws and lockwashers to specifications.
   - Tighten all clamps securely.



a - Mating Surface
b - "O" Ring

Figure 2. Exhaust Pipe Mounting Surface



a - Clamps
b - Exhaust Bellows
c - Exhaust Pipe Elbow - Early Models Use Casting 94443 On Both Sides, Later Models Use Casting 94443 On Starboard Side and Casting 94444 On Port Side
d - Exhaust Hose
e - Water Shutters
f - Screws and Lockwashers
g - Exhaust Pipe - Refer to Part List for Correct One

Figure 3. Exhaust System Components

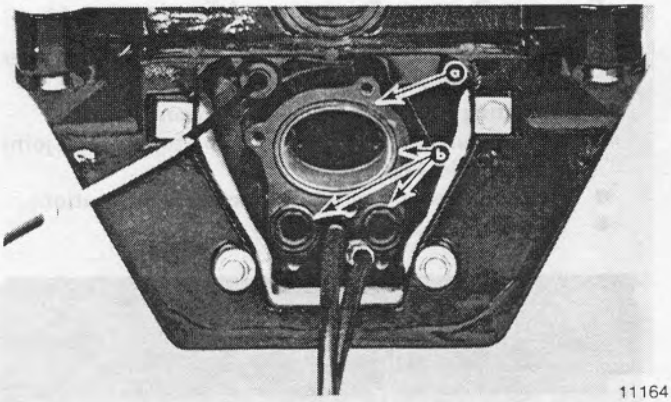
MCM 898/898R/228/228R/260/260R DRIVE-SHAFT EXTENSION MODELS

Shutter Replacement

1. Loosen hose clamps on exhaust hose and remove screws and lockwashers. (Figure 3)
2. Remove exhaust pipe elbow.
3. Remove water shutter, then retainer from tee pipe.
4. Install retainer, then shutter as shown in Figure 3.
5. Make sure mating surfaces are clean and "O" ring is in groove.
6. Reinstall exhaust pipe elbow with screws and lockwashers, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
7. Tighten clamps securely.

Exhaust System Component Replacement

1. To replace any component in system as shown in Figures 1, 2 or 3. The following must be adhered to:
   - All mating joint surfaces must be clean.
   - "O" rings must remain in groove to properly seal joints to prevent leakage.
   - Torque all screws and lockwashers to specifications.
   - Tighten all clamps securely.



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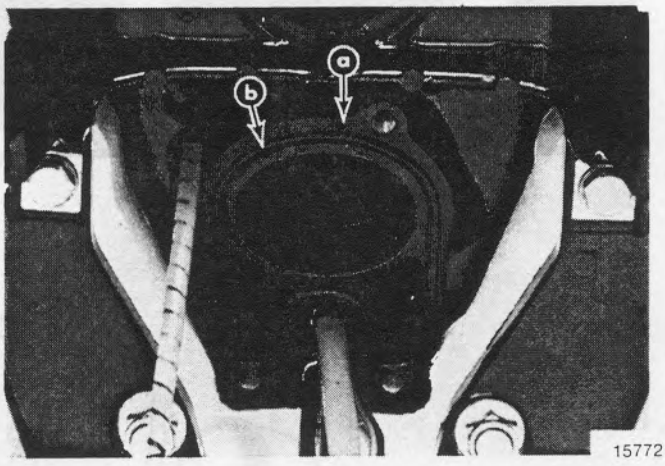
a - Mating Surface
b - "O" Rings

Figure 1. Exhaust Tee Pipe Mounting Surface - Early Models



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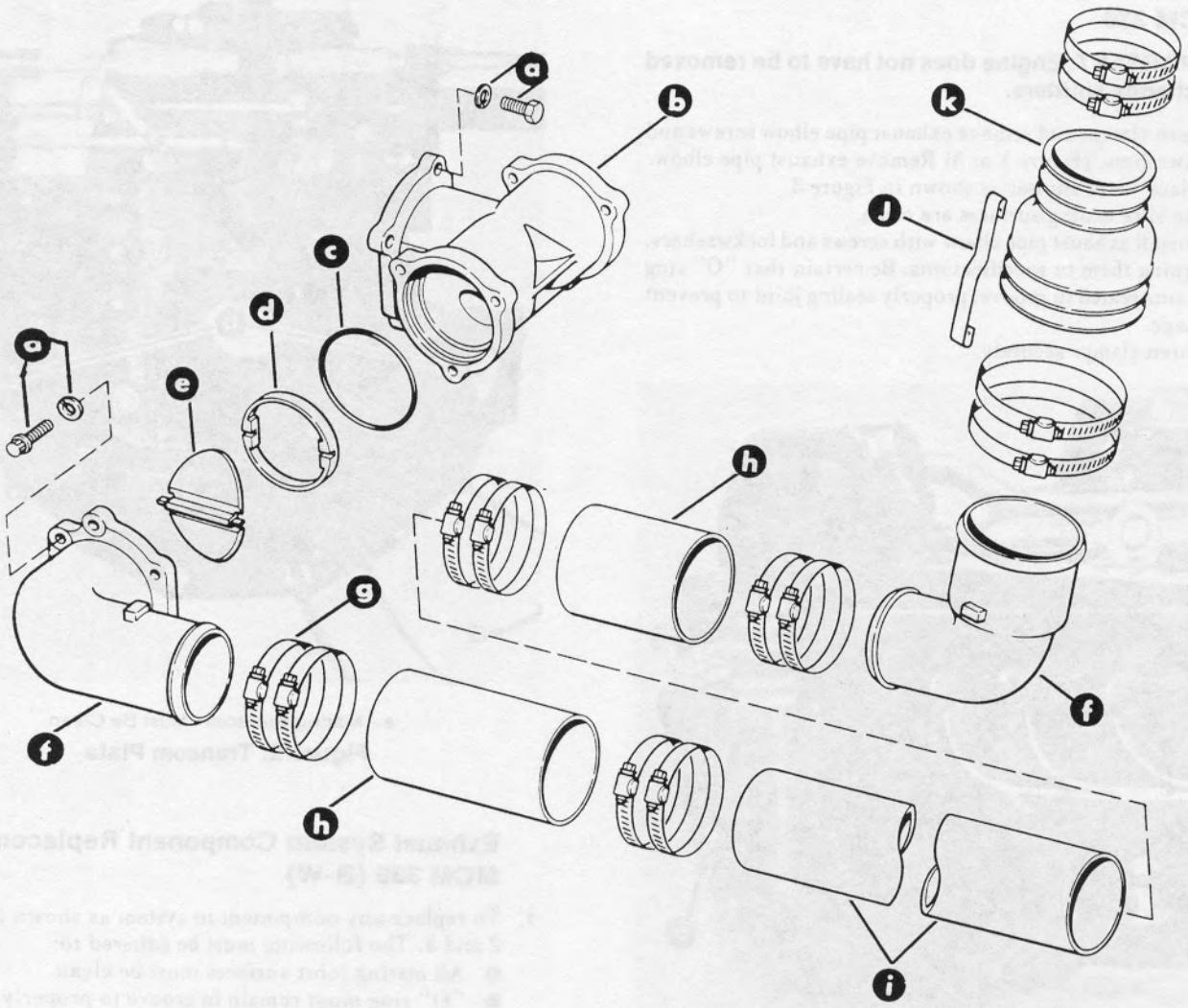
a - Mating Surface
b - "O" Ring

Figure 2. Exhaust Tee Pipe Mounting Surface - Later Models



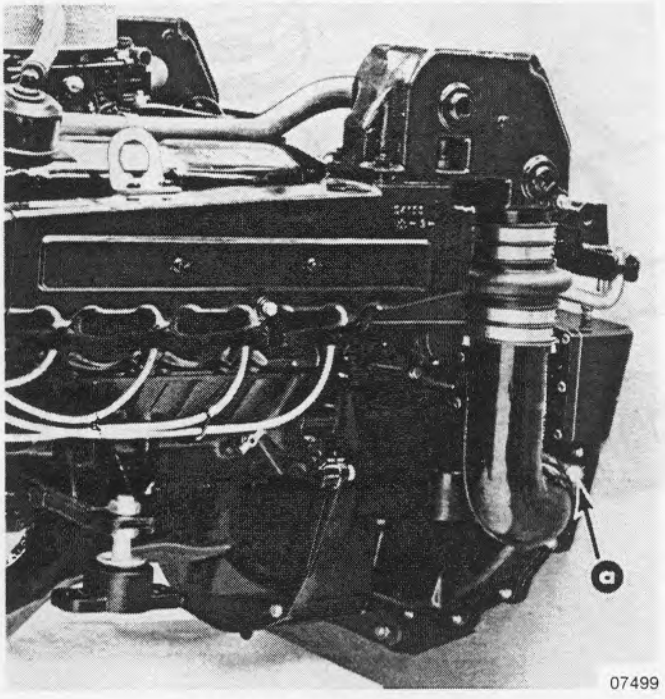
a - Screws and Lockwashers
b - Tee Pipe
c - "O" Ring
d - Retainer - Slots Facing Out
e - Water Shutter - Opens Toward Inside of Tee Pipe
f - Exhaust Pipe Elbow
g - Clamps
h - Exhaust Hose
i - Exhaust Tube
j - Ground Strap
k - Exhaust Bellows

Figure 3. Exhaust System Components

Exhaust Pipe and Shutter Replacement MCM 330

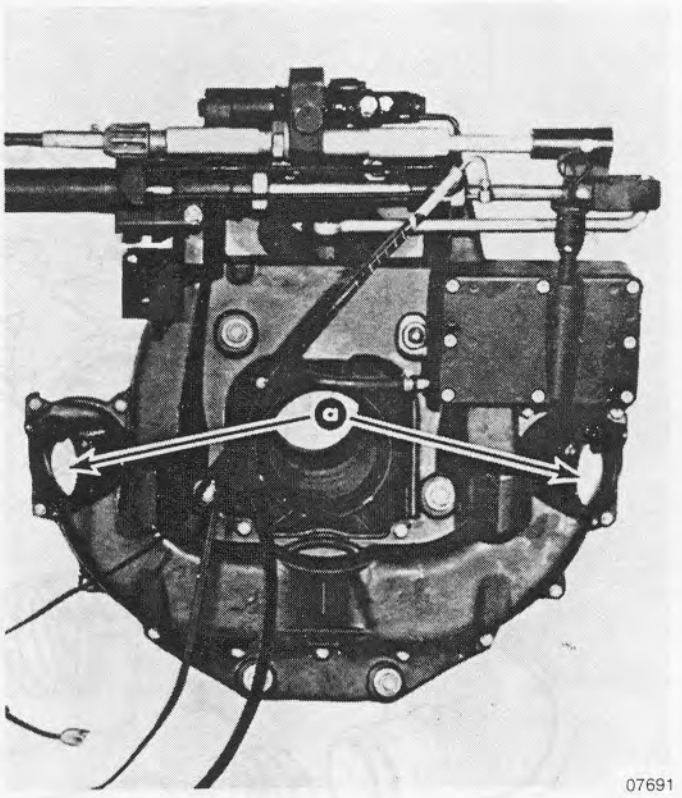
IMPORTANT: Engine does not have to be removed to change shutters.

1. Loosen clamps and remove exhaust pipe elbow screws and lockwashers. (Figure 1 or 3) Remove exhaust pipe elbow.
2. Replace water shutter as shown in Figure 3.
3. Make sure mating surfaces are clean.
4. Reinstall exhaust pipe elbow with screws and lockwashers, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
5. Tighten clamps securely.



a - Screws and Lockwashers (3)

Figure 1. MCM 330

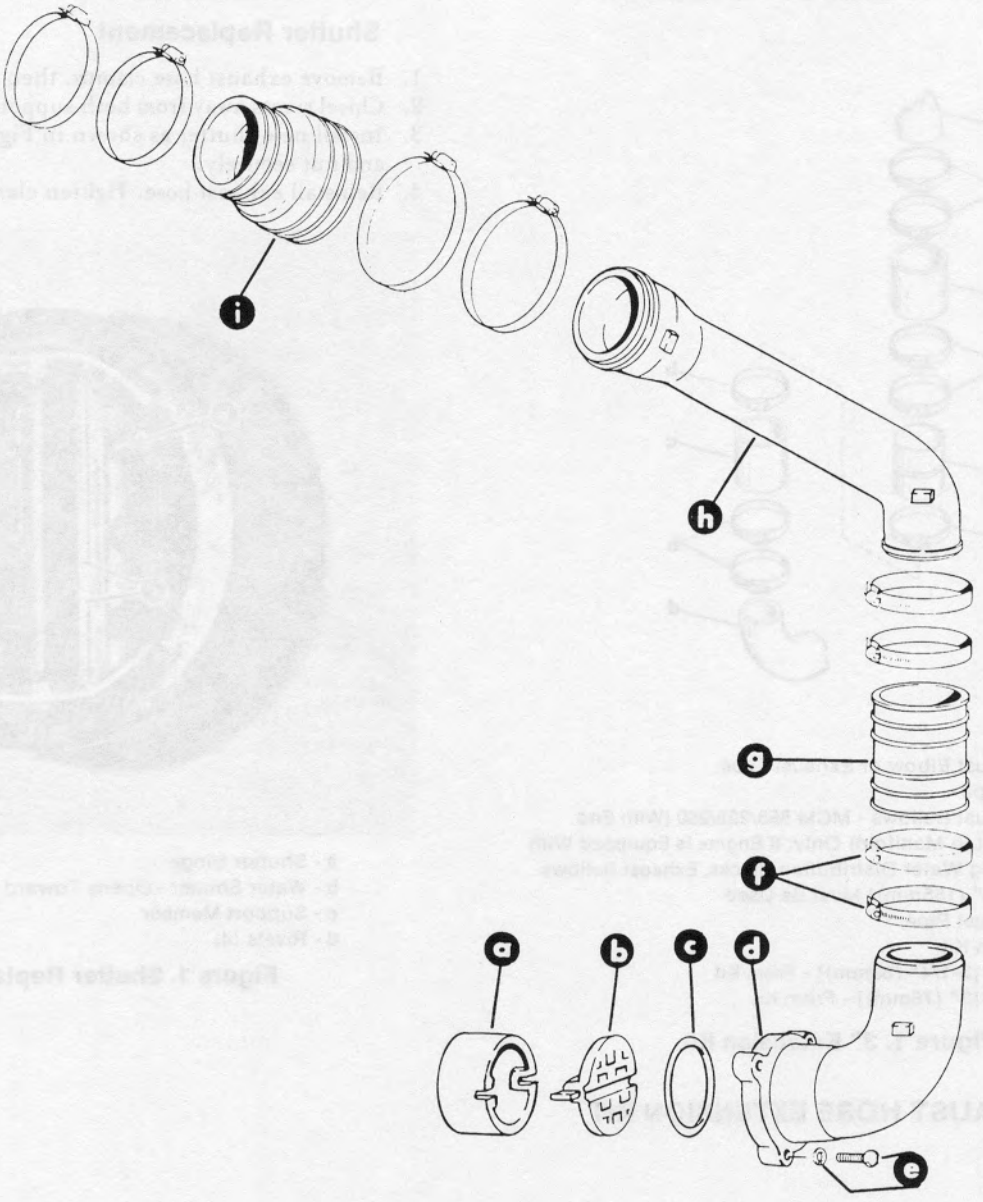


a - Mating Surfaces - Must Be Clean

Figure 2. Transom Plate

Exhaust System Component Replacement MCM 330 (B-W)

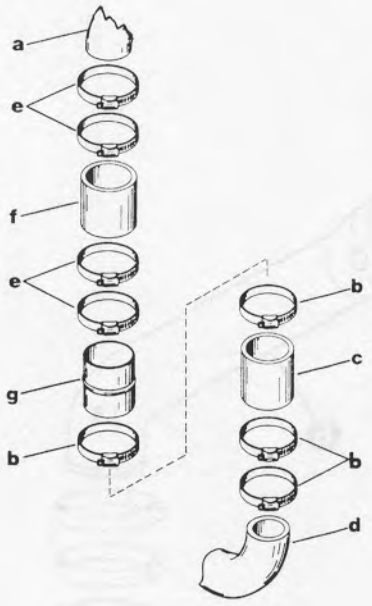
1. To replace any component in system as shown in Figures 2 and 3. The following must be adhered to:
   - All mating joint surfaces must be clean.
   - "O" ring must remain in groove to properly seal joint to prevent leakage.
   - Torque all screws and lockwashers to specifications.
   - Tighten all clamps securely.



a - Retainer - Slots Toward Exhaust Pipe Elbow
b - Shutters - Opens Toward Transom Plate
c - "O" Ring
d - Exhaust Pipe Elbow
e - Screws and Lockwashers (3 Per Side)
f - Clamps
g - Exhaust Hose
h - Exhaust Pipe
i - Exhaust Bellows

Figure 3. MCM 330 (B-W)

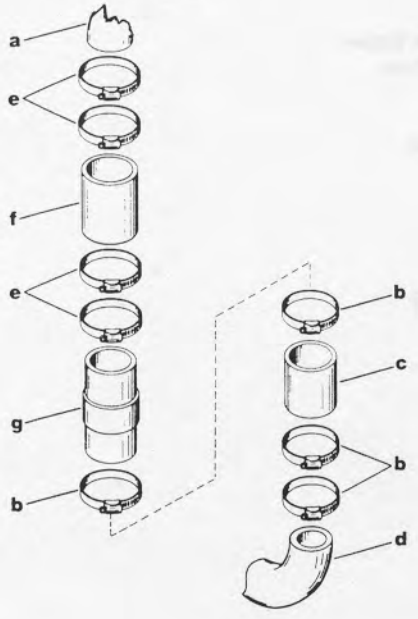
MCM 3" EXHAUST HOSE EXTENSION KIT 32-62364A1



a - Original Exhaust Elbow or Exhaust Tube
b - Original Clamps
c - Original Exhaust Bellows - MCM 898/228/260 (With End Exhaust Outlet in Manifold) Only: If Engine Is Equipped With Closed Cooling Water Distribution Blocks, Exhaust Bellows [72408, 6-7/64" (155mm)] Must Be Used
d - Original Exhaust Pipe
e - Clamps - From Kit
f - Exhaust Hose [3-1/4" (83mm)] - From Kit
g - Exhaust Tube [3" (76mm)] - From Kit

Figure 1. 3" Extension Kit

MCM 6" EXHAUST HOSE EXTENSION KIT 32-59077A1



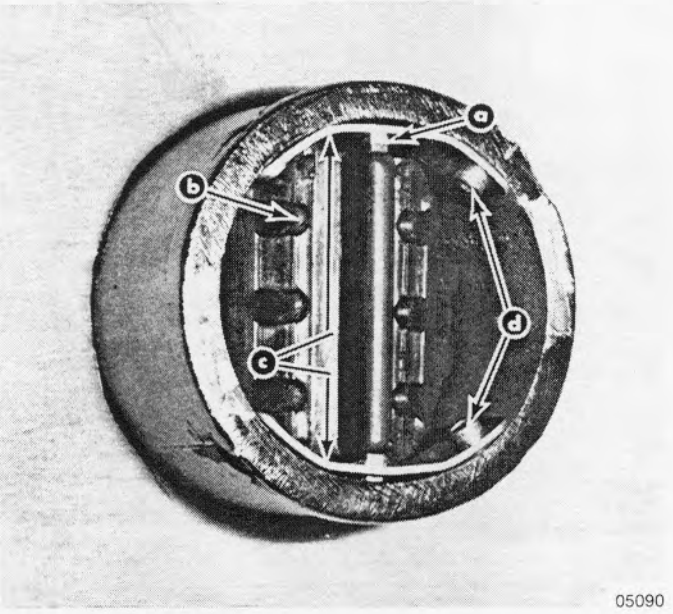
a - Original Exhaust Elbow or Exhaust Tube
b - Original Clamps
c - Original Exhaust Bellows - MCM 898/228/260 (With End Exhaust Outlet in Manifold) Only: If Engine Is Equipped With Closed Cooling Water Distribution Blocks, Exhaust Bellows [72408, 6-7/64" (155mm)] Must Be Used
d - Original Exhaust Pipe
e - Clamps - From Kit
f - Exhaust Hose [4" (102mm)] - From Kit
g - Exhaust Tube [5-13/16" (148mm)] - From Kit

Figure 2. 6" Extension Kit

THRU TRANSOM EXHAUST FLANGE

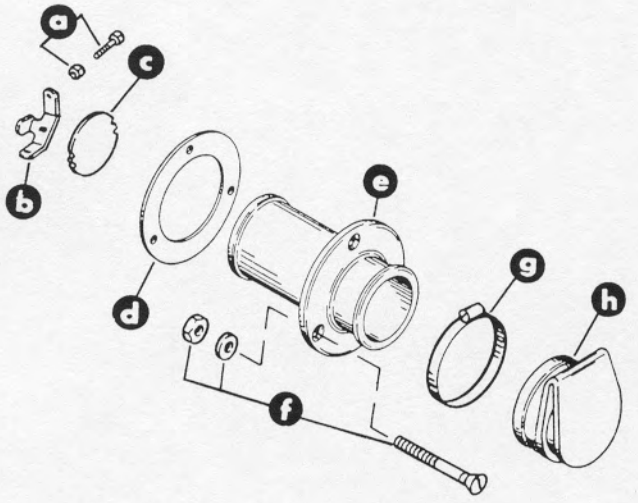
Shutter Replacement

1. Remove exhaust hose clamps, then hose.
2. Chisel rivets away from both support members. (Figure 1)
3. Install new shutter as shown in Figure 1. Tighten screws and nut securely.
4. Reinstall exhaust hose. Tighten clamps securely.



a - Shutter Hinge
b - Water Shutter - Opens Toward Outside of Boat
c - Support Member
d - Rivets (4)

Figure 1. Shutter Replacement

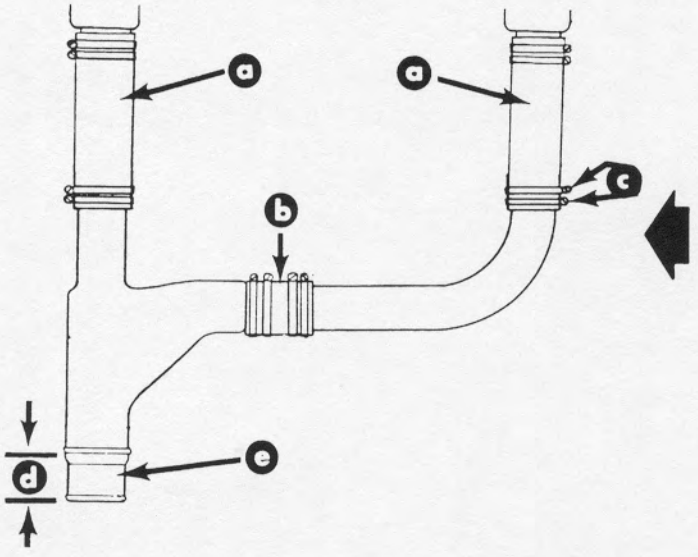


a - Screw and Nut (4)
b - Support Member
c - Water Shutter
d - Gasket
e - Exhaust Flange
f - Screws, Washers and Nuts (3)
g - Clamp
h - Cover ("Flapper")

Figure 2. Thru Transom Exhaust Flange

MIE 228/230/255/260 SINGLE EXHAUST KIT 48640A2

IMPORTANT: Because of high back-pressure, DO NOT use this kit with 454 CID (7.4 ltr) engines.

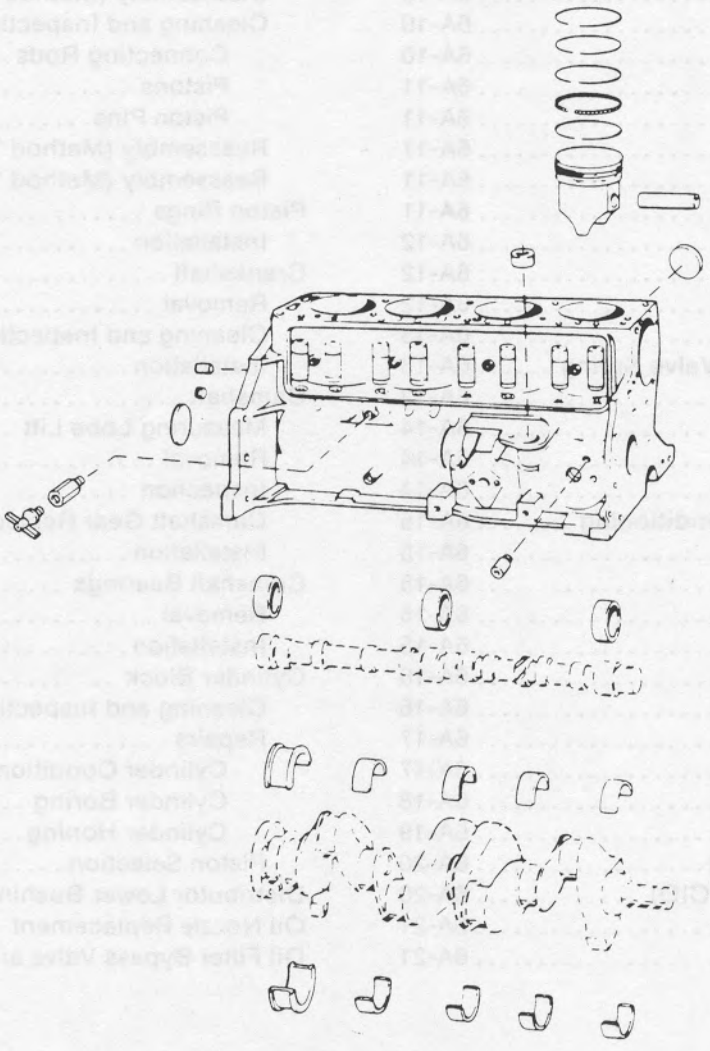


a - Hose - Cut to Fit
b - Hose - 4" (102mm) Long
c - Clamps - 2 At Each Connection, Tighten Securely
d - Cut 2-3/8" (60mm) From End of "Y" Pipe to Allow Use of 4" (102mm) Exhaust Hose
e - Connect to Thru Transom Exhaust Hose

Figure 1. Exhaust Pipes and Hose Installation

SECTION 6 - ENGINE

PART A - G.M. IN-LINE



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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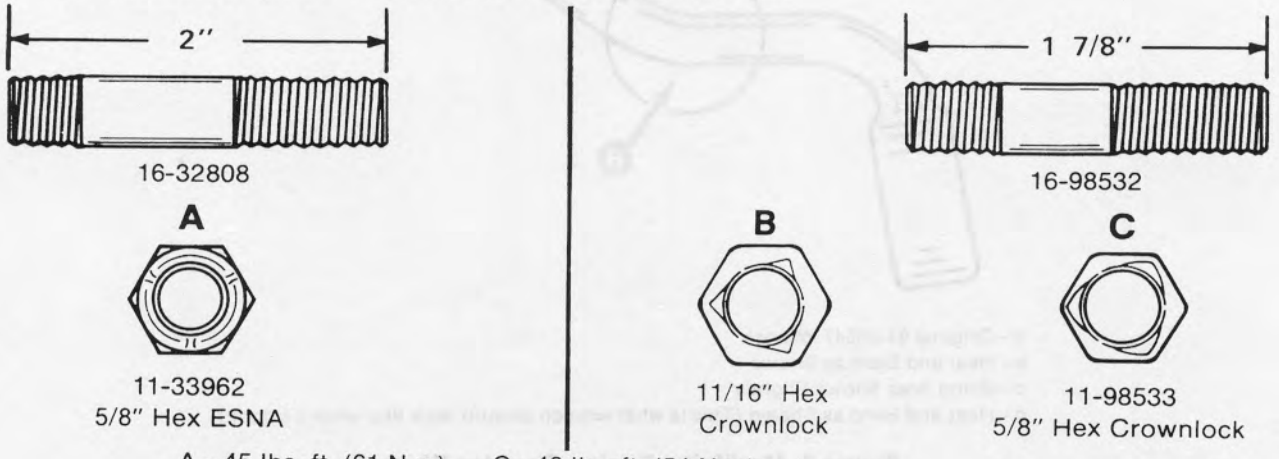
TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Camshaft Thrust Plate	6 (8)
Connecting Rod Cap (11/32-24)	33 (45)
Connecting Rod Cap (3/8-24)	40 (54)
Crankshaft Pulley (5/16-24)	18 (24)
Crankshaft Pulley (3/8-24)	23 (31)
Cylinder Head	Δ 93 (126)
Distributor Clamp	20 (27)
Engine Coupler/Flywheel	See Figure 1
Flywheel Housing to Block	21 (28)
Front Mount to Block	21 (28)
Main Bearing Cap	65 (88)
Manifold to Head	□ 23 (31)
Oil Pan - Side (1/4-20)	7 (9)
Oil Pan - End (5/16-18)	10 (14)
Oil Pan Drain Plug	23 (31)
Oil Pump Cover	6 (8)
Oil Pump to Block	10 (14)
Oil Pump Pickup	5 (7)
Rocker Arm Cover	4 (5)
Spark Plugs	15 (20)
Starter Motor	37 (50)
Thermostat Cover	20 (27)
Timing Gear Cover	6 (8)
Water Pump to Block	15 (20)

Δ *Retorque after first 20 hours of operation.* □ *Retorque after first start up.*

IMPORTANT: DO NOT intermix stud/nut combinations.

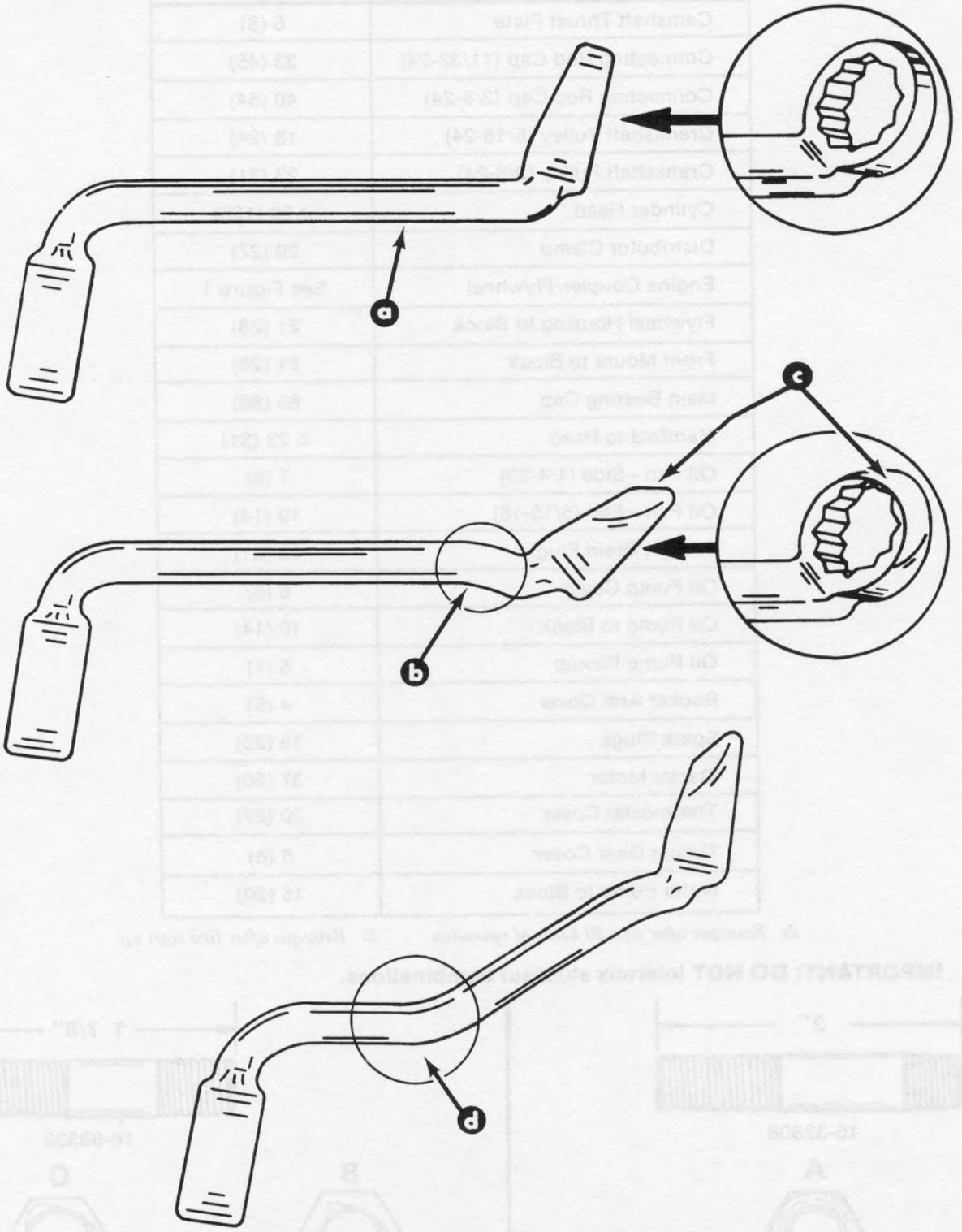


A - 45 lbs. ft. (61 N.m) C - 40 lbs. ft. (54 N.m)
B - 35 lbs. ft. (42 N.m) D - See Figure 2 For Coupler Wrench Modification

269-H

Figure 1. Engine Coupler/Flywheel Torque

Engine Coupler Wrench, 91-35547, may not work on the later couplers. Modify wrench as shown in Figure 2, so it will work on both earlier and later style couplings.



a - Original 91-35547 Wrench
b - Heat and Bend as Shown
c - Grind Area Shown Slightly
d - Heat and Bend as Shown (This is what wrench should look like when it's done)

Figure 2. Modifying Engine Coupler Wrench

TOOLS/LUBRICANTS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-35547	Engine Coupler Wrench
91-24697	Piston Ring Expander
91-63209	Torch Lamb

KENT-MOORE SPECIAL TOOLS	
Kent-Moore Special Tools can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone 313-774-9500	
J5892	Valve Spring Compressing
J8062	Valve Spring Compressor
J8056	Valve Spring Tester
J8101	Valve Guide Cleaner
J8814	Valve Guide Reamer (Standard)
J5830-2	Valve Guide Reamer (.015" O.S.)
J5802-01	Rocker Arm Stud Remover
J6880	Rocker Arm Stud Installer
J5715	Stud Bore Reamer (.003" O.S.)
J6036	Stud Bore Reamer (.013" O.S.)
J8089	Carbon Remover Brush
J9510-1	Piston Support Tool
J24086-100	Piston Pin Tool
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J5239	Connecting Rod Guide Tool (3/8"-24)
J8087	Cylinder Bore Checker
J8369	Oil Pump Suction Pipe Installer
J23042	Timing Cover Seal Aligner
J8520	Cam Lobe Lift Indicator
J6098-01	Camshaft Bearing Installer/ Remover Tool
J9534-01	Distributor Shaft Lower Bearing Installer/Remover
J6978-E	Pulley Hub Puller
J5590	Pulley Hub Installer
J22197	Universal Vibration Dampner Installer
J24420-A	Universal Vibration Dampner Remover

LUBRICANTS/SEALANTS	
92-34227	Quicksilver Perfect Seal
92-86154A1	Quicksilver 2-4-C Multi-Lube
92-91601-1	Quicksilver RTV Sealer

ENGINE SPECIFICATIONS

UNIT OF MEASUREMENT
in. (mm)

MODEL	120	140	165
DISPLACEMENT	153 CID	181 CID	250 CID

CYLINDER BORE:

Diameter			3.8745-3.8775 (98.412-98.489)	3.9995-4.0075 (101.5873-101.7905)	3.8745-3.8775 (98.412-98.489)
Out of Round		Production	.0005 (.0127) Max.		
		Service	.002 (.0508) Max.		
Taper	Production	Thrust Side	.0005 (.0127) Max.		
		Relief Side	.0005 (.0127) Max.		
	Service		.0005 (.0127) Max.		

PISTON: CLEARANCE

Production	.0005-.0015 (.0127-.0381)
Service	.0025 (.06) Max.

PISTON RING: COMPRESSION

Groove Clearance	Production	Top	.0012-.0027 (.0305-.0686)
		2nd	.0012-.0032 (.0305-.0813)
	Service	Top	.001-.003 (.03-.09)
		2nd	.001-.004 (.03-.1)
Gap	Production	Top	.010-.020 (.254-.508)
		2nd	.010-.020 (.254-.508)
	Service	Top	.010-.030 (.25-.75)
		2nd	.010-.030 (.25-.75)

PISTON RING: OIL

Groove Clearance	Production	.000-.005 (.127)
	Service	.000-.006 (.15)
Gap	Production	.015-.055 (.381-1.397)
	Service	.015-.065 (.4-1.65)

PISTON PIN:

Diameter		.9270-.9273 (23.546-23.553)
Clearance	Production	.00015-.00025 (.038-.006)
	Service	.001 (.025) Max.
Fit in Rod		.0008-.0016 (.020-.041) Interference

CRANKSHAFT:

Main Journal	Diameter		All 2.2983-2.2993 (5.838-5.840)
	Taper	Production	.0002 (.005) Max.
		Service	.001 (.025) Max.
	Out of Round	Production	.0002 (.005) Max.
		Service	.001 (.025) Max.
Main Brg. Clearance	Production		.0003-.0029 (.008-.074)
	Service		.004 (.1) Max.

(Continued on Next Page)

ENGINE SPECIFICATIONS
(Continued)

MODEL			120	140	165
Crankshaft End Play			.002-.006 (.05-.15) Max.		
Crankpin	Diameter		1.999-2.000 (50.775-50.800)	2.099-2.100 (53.315-53.340)	1.999-2.000 (50.775-50.800)
	Taper	Production	.0003 (.0076) Max.		
		Service	.001 (.025) Max.		
	Out of Round	Production	.0002 (.051) Max.		
		Service	.001 (.025) Max.		
Rod Brg. Clearance	Production		.0007-.0027 (.018-.069)	.0007-.0028 (.018-.071)	.0007-.0027 (.018-.069)
	Service		.004 (.1) Max.		
Rod Side Clearance			.009-.013 (.25-.3)		

CAMSHAFT:

Lobe Lift (Max.)	Intake	.2325 (5.906)	.2525 (6.414)	.2297 (5.834)
	Exhaust	.2325 (5.906)	.2525 (6.414)	.2297 (5.834)
Journal Diameter		1.8682-1.8692 (47.452-47.478)		
Camshaft Runout		.0015 (.038) Max.		

CYLINDER HEAD:

Gasket Surface Flatness	.003" (.07) in Any 6" (152) or .007" (.15) Overall Max.

VALVE SYSTEM:

Lifter			Hydraulic		
Rocker Arm Ratio			1.75 to 1		
Collapsed Tappet Gap			1 Turn Down from "O" Lash		
Face Angle		Intake	45°		
		Exhaust	45°		
Seat Angle (Int. & Exh.)			46°		
Seat Runout (Int. & Exh.)			.002 (.051) Max.		
Seat Width		Intake	1/32-1/16 (.8-1.6)		1/32-3/32 (.8-2.4)
		Exhaust	1/16-3/32 (1.6-2.4)		
Stem Clearance	Production	Int.	.0010-.0027 (.025-.069)		
		Exh.	.0015-.0032 (.038-.081)		
	Service	Int.	.0037 (.094) Max.		
		Exh.	.0052 (.132) Max.		
Springs	Free Length		2-5/16 [2.08 (53)]		1-29/32 [1.90 (48)]
	Pressure Lbs. Ft.	Closed	78-86 (106-116 N.m) at 1-21/32 [1.66 (42.2)]	83 (113 N.m) at 1-21/32 [1.66 (42.2)]	54-64 (73-86 N.m) at 1-21/32 [1.66 (42.2)]
		Open	170-180 (230-244 N.m) at 1-17/64 [1.26 (32)]	175 (237 N.m) at 1-17/64 [1.26 (32)]	180-192 (244-260 N.m) at 1-17/64 [1.27 (32.3)]
	Installed Height ± 1/32" (.8)	Intake	1-21/32 [1.6562 (42.07)]		
		Exhaust	1-21/32 [1.6562 (42.07)]		
Damper	Free Length		1-15/16 [1.94 (49.2)]		
	Approx. No. of Coils		4		

GENERAL

Some Repairs, Listed in This Section, Must Be Completed with Engine Removed from Boat. Engine Removal Depends Upon Type of Repair and Boat Design. Place Engine on Engine Stand for Major Repairs.

In-line engines with 153, 181, and 250 cu. in. displacements are covered in this section.

Full pressure lubrication thru a full flow oil filter is furnished by a gear-type oil pump. Distributor, driven by a helical gear on camshaft, drives oil pump. Main oil gallery feeds oil thru drilled passages to camshaft and crankshaft to lubricate bearings. Main oil gallery also feeds valve lifters which, thru push rods, feed individually-mounted rocker arms.

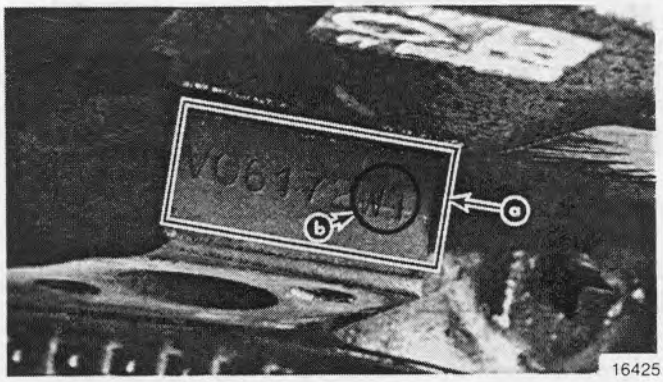
Cubic inch displacement (CID) of each MerCruiser model is listed below.

Model	No. of Cylinders	Cu. In. Displacement
MCM 120	4	153 (2.5 ltr.)
MCM 140	4	181 (3 ltr.)
MCM 165	6	250 (4 ltr.)

ENGINE IDENTIFICATION

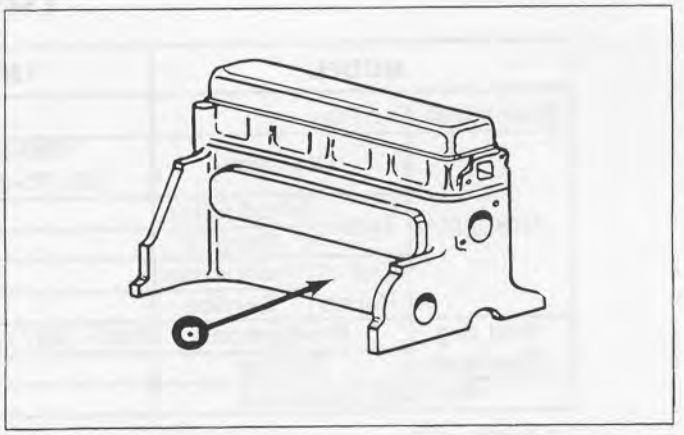
The MerCruiser Model can be determined by looking at the LAST TWO LETTERS of the engine code stamped into the cylinder block. (Figure 1) This code number is stamped on all MerCruiser Power Packages and replacement partial engines but not replacement cylinder block assemblies.

If the engine serial number, and/or model decals are missing, the engine code letters may help in determining the engine model. Following is a list of G.M. engines and their respective code letters.



a - Engine Code (V06172WT)
b - Last Two Letters (WT)

Figure 1. G.M. Engine Code (V-8 Shown)



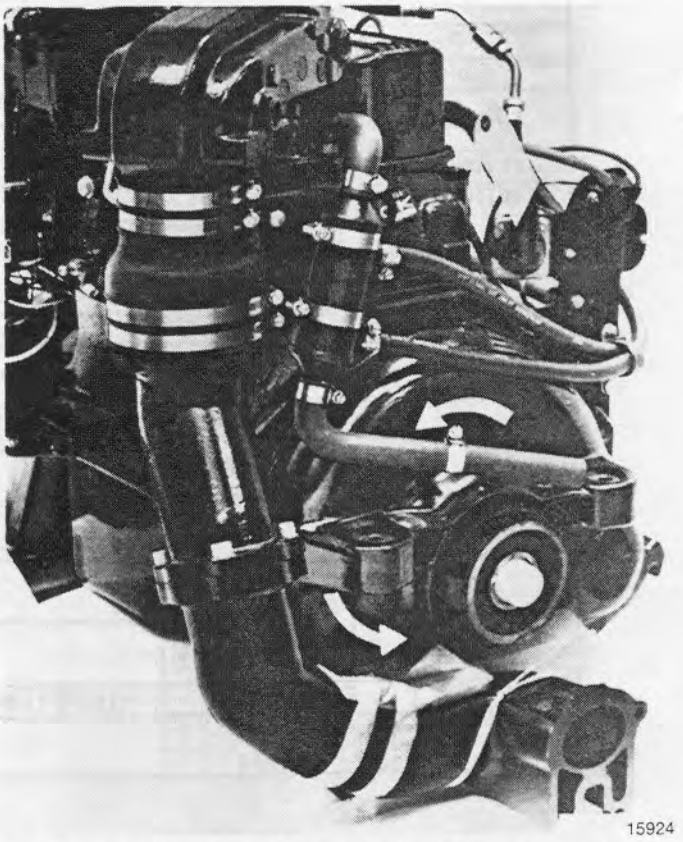
a - 4 and 6 Cylinder-In-Line (Near Distributor)

Figure 2. G.M. Engine Code Location

MCM Stern Drive Engines (All Are LH Rotation)

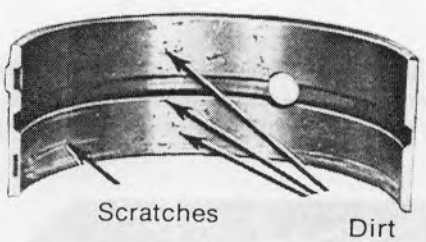
120-NB
140-RA
165-SD

ENGINE ROTATION



All Engines Are Left Hand Rotation When Viewed from Flywheel End

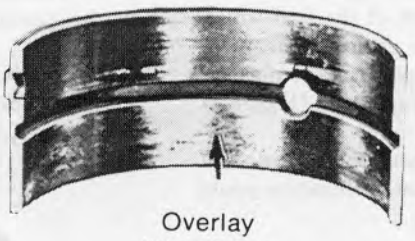
Bearing Failures



Scratches

Dirt Imbedded into Bearing Material

SCRATCHED BY DIRT



Overlay Wiped Out

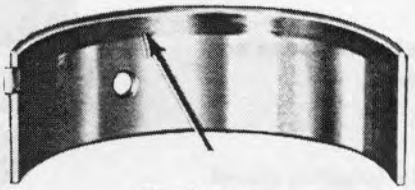
LACK OF OIL

Bright (Polished) Sections

IMPROPER SEATING

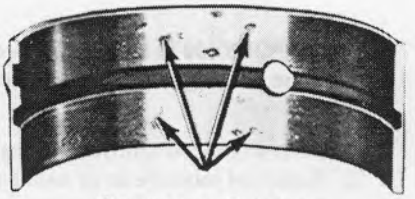
Overlay Gone from Entire Surface

TAPERED JOURNAL



Radius Ride

RADIUS RIDE



Craters or Pockets

FATIGUE FAILURE

Piston Failures

PRE-IGNITION

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion of the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature. (Figure 1)

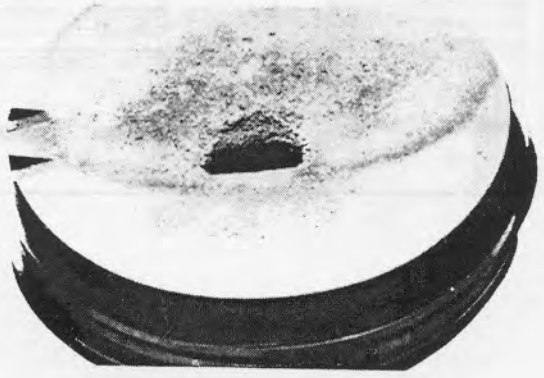
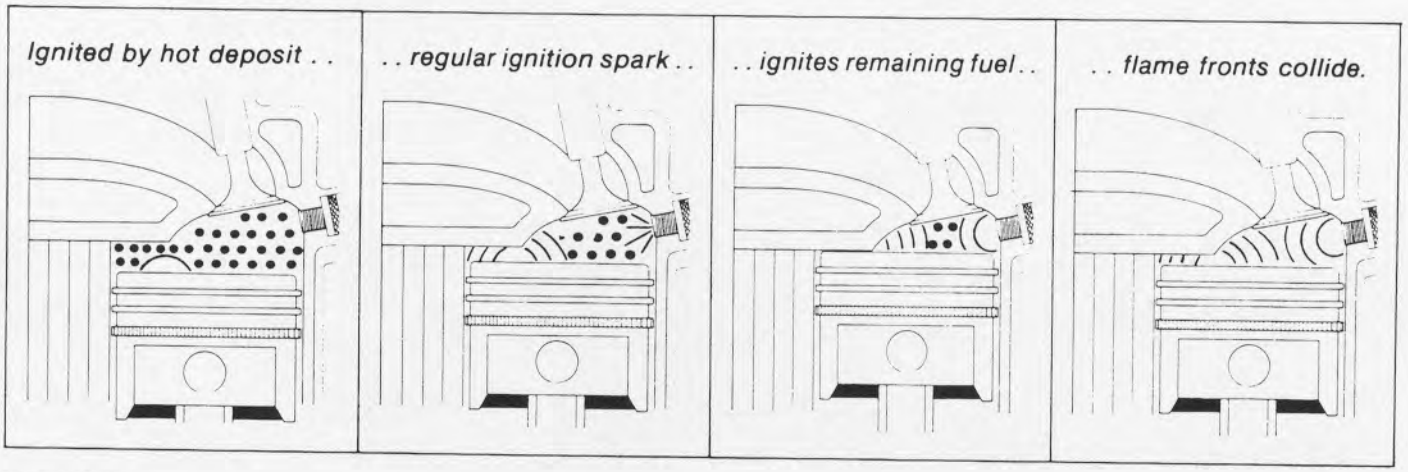


Figure 1. Pre-Ignition Damage

Pre-Ignition Causes

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.



DETONATION

Detonation, commonly called "fuel knock", "spark knock" or "carbon knock", is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition. (Figure 2)

Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

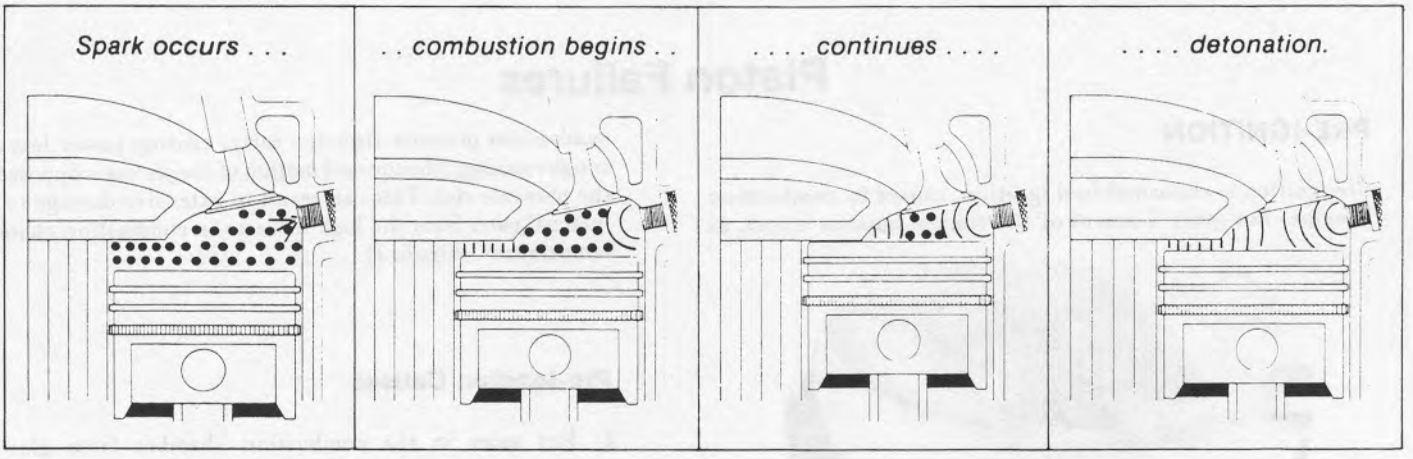
Other Causes of Detonation

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

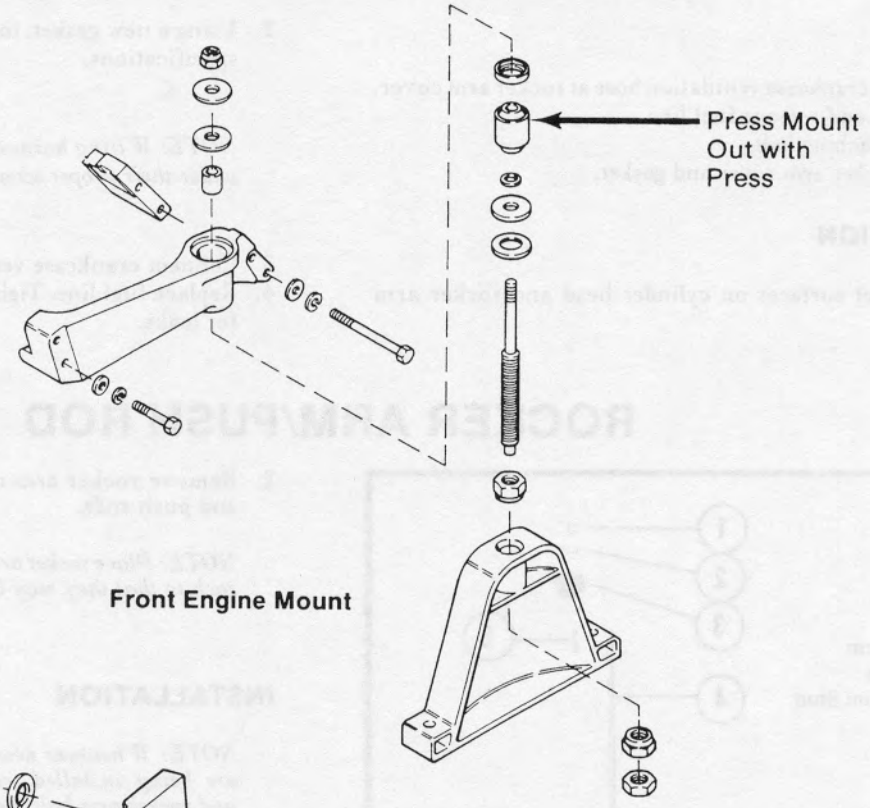
1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.

Figure 2. Detonation Damage

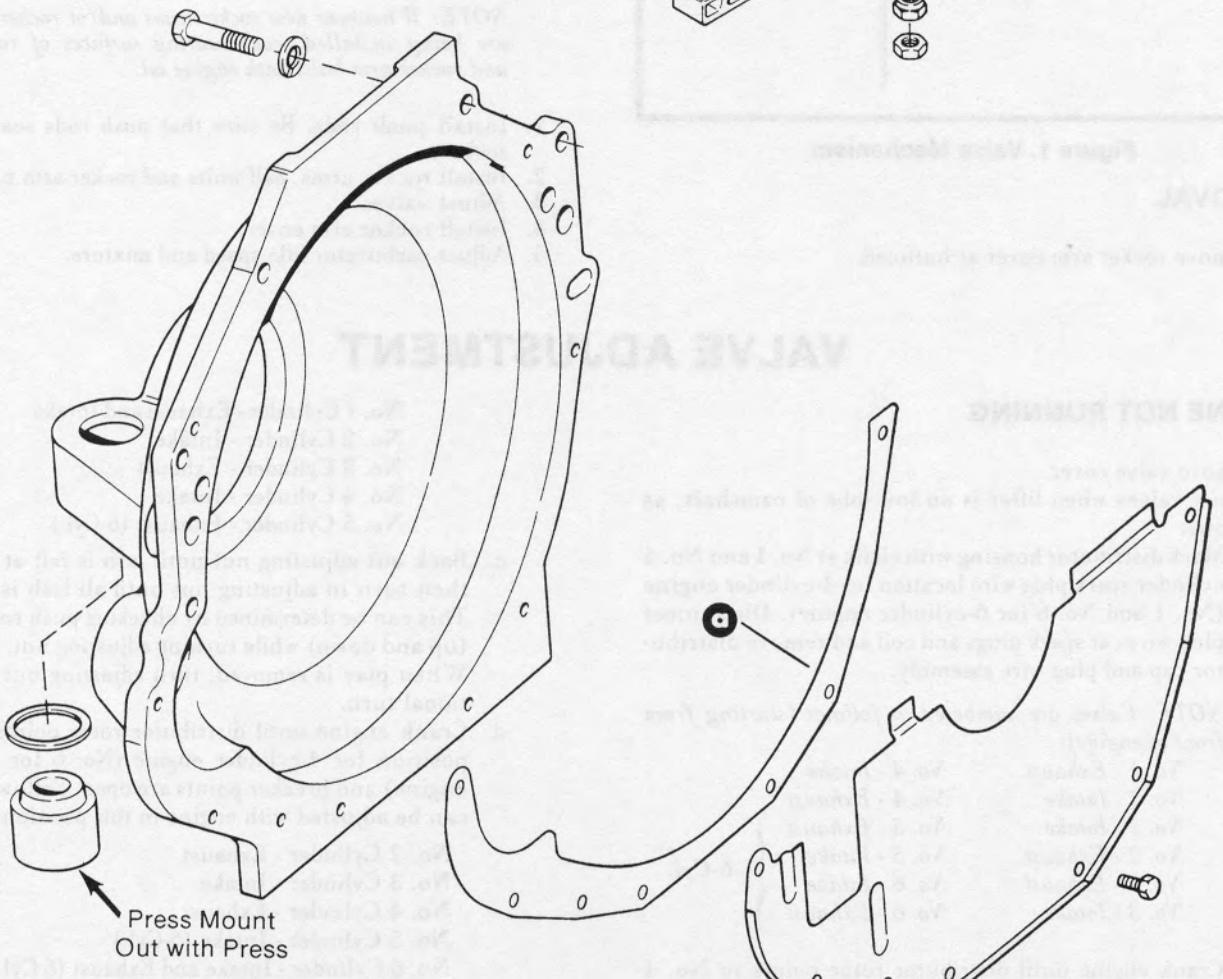


FRONT/REAR ENGINE MOUNT



Front Engine Mount

MC0034



a. Gasket used on 120R/140R Engines Only

MC0028

Rear Engine Mount/Flywheel Housing

ROCKER ARM COVER

REMOVAL

1. Disconnect crankcase ventilation hose at rocker arm cover.
2. Disconnect and remove fuel line.
3. Remove attaching bolts.
4. Remove rocker arm cover and gasket.

INSTALLATION

1. Clean gasket surfaces on cylinder head and rocker arm cover.
2. Using a new gasket, install rocker arm cover and torque to specifications.

   NOTE: Wiring harness and inlet hose clips must be installed under their proper screws.

3. Connect crankcase ventilation hoses.
4. Replace fuel line. Tighten connections securely and check for leaks.

ROCKER ARM/PUSH ROD

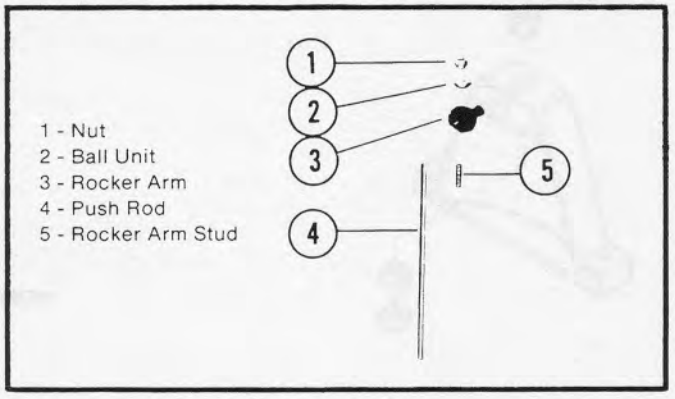


Figure 1. Valve Mechanism

REMOVAL

1. Remove rocker arm cover as outlined.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and push rods.

   NOTE: Place rocker arms, rocker arm balls and push rods in a rack so that they may be reinstalled in same location.

INSTALLATION

NOTE: Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

1. Install push rods. Be sure that push rods seat in lifter socket.
2. Install rocker arms, ball units and rocker arm nuts.
3. Adjust valves.
4. Install rocker arm cover.
5. Adjust carburetor idle speed and mixture.

VALVE ADJUSTMENT

ENGINE NOT RUNNING

1. Remove valve cover.
2. Adjust valves when lifter is on low lobe of camshaft, as follows:
   a. Mark distributor housing with chalk at No. 1 and No. 4 cylinder spark plug wire location for 4-cylinder engine (No. 1 and No. 6 for 6-cylinder engine). Disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly.

      NOTE: Valves are numbered as follows (starting from front of engine):

No. 1 - Exhaust	*No. 4 - Intake*	
No. 1 - Intake	*No. 4 - Exhaust*	
No. 2 - Intake	*No. 5 - Exhaust*	*6-Cyl.*
No. 2 - Exhaust	*No. 5 - Intake*	
No. 3 - Exhaust	*No. 6 - Intake*	
No. 3 - Intake	*No. 6 - Exhaust*	

   b. Crank engine until distributor rotor points to No. 1 cylinder position and breaker points are open. Following valves can be adjusted with engine in No. 1 firing position.

      No. 1 Cylinder - Exhaust and Intake
      No. 2 Cylinder - Intake
      No. 3 Cylinder - Exhaust
      No. 4 Cylinder - Intake
      No. 5 Cylinder - Exhaust (6-Cyl.)

   c. Back out adjusting nut until lash is felt at push rod, then turn in adjusting nut until all lash is removed. This can be determined by checking push rod end play (up and down) while turning adjusting nut. (Figure 2) When play is removed, turn adjusting nut in 1 additional turn.
   d. Crank engine until distributor rotor points to No. 4 position for 4-cylinder engine (No. 6 for 6-cylinder engine) and breaker points are open. Following valves can be adjusted with engine in this position:

      No. 2 Cylinder - Exhaust
      No. 3 Cylinder - Intake
      No. 4 Cylinder - Exhaust
      No. 5 Cylinder - Intake (6-Cyl.)
      No. 6 Cylinder - Intake and Exhaust (6 Cyl.)
3. Install distributor cap, spark plug wires and coil lead.
4. Install rocker arm cover.

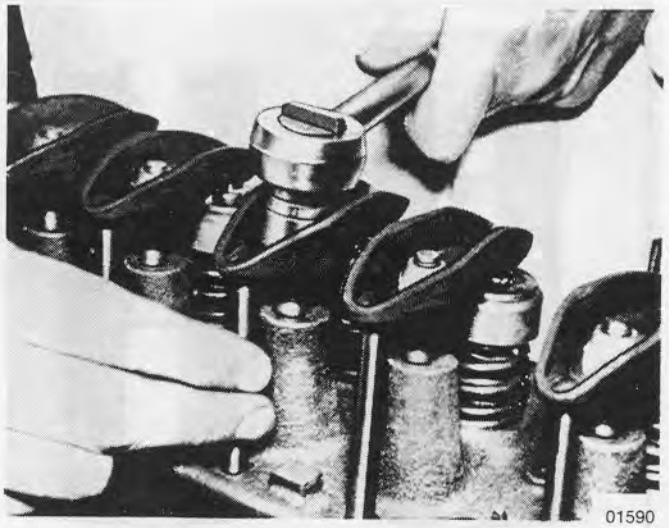


Figure 2. Valve Adjustment

ENGINE RUNNING

Following procedure should be completed only if readjustment is required.

1. Run engine until it reaches normal operating temperature, then remove valve cover.
2. With engine running at idle, back off valve rocker arm nut until valve rocker arm starts to clatter. (Figure 2)
3. Turn rocker arm nut down slowly until clatter just stops. This is zero lash position.
4. Turn nut down ¼ additional turn and pause 10 seconds until engine runs smoothly. Repeat additional ¼ turns, pausing 10 seconds each time, until nut has been turned down 1 turn from zero lash position.

   NOTE: This 1 turn pre-load adjustment must be done slowly to allow lifter to adjust itself, thus preventing possible interference between inlet valve head and top of piston which might result in internal damage and/or bend push rods.

5. Repeat Steps 2-3-4 to adjust other valves.
6. Install valve cover, using new gasket.
7. Adjust carburetor.

HYDRAULIC VALVE LIFTERS

Refer to Figure 3 for parts identification.

Hydraulic valve lifters seldom require attention. Lifters are simple in design, readjustments are not necessary and lifter servicing requires only that care and cleanliness be exercised in handling of parts.

LOCATING NOISY LIFTERS

Use a piece of garden hose approximately 4 ft. (1.2m) in length to locate a noisy valve lifter. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. Sound, thus, is localized, making it easy to determine which lifter is at fault. Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat. General types of valve lifter noise are:

1. Hard Rapping Noise - Usually caused by plunger becoming tight in bore of lifter body to such an extent that return spring can no longer push plunger back up to working position. Probable causes are -
   a. Excessive varnish or carbon deposit which causes abnormal stickiness.
   b. Galling or "pickup" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedging between plunger and lifter body.
2. Moderate Rapping Noise - Probable causes are -
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General Noise Throughout Valve Train - This, in most cases, will be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent Clicking - Probable causes are -
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in a solvent, reassembled and reinstalled in engine. If dirt, varnish, carbon, etc, are shown to exist in one unit, it likely exists in all units. Thus, it would be only a matter of time before all lifters cause trouble.

REMOVAL

1. Remove rocker arm and push rod.
2. Mark distributor housing with chalk at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly.
3. Crank engine until distributor rotor points to No. 1 position, then disconnect distributor primary lead at coil and remove distributor.
4. Remove push rod covers (discard gaskets).
5. Remove valve lifters.

   NOTE: Place valve lifters in a rack so they may be reinstalled in same location.

SERVICING

Two types of hydraulic lifters are used. Both types operate on same principle and are serviced basically in same manner. Complete lifter assemblies are interchangeable, but parts from one lifter are not interchangeable with another. Both lifters are easily identified by outside configuration of lifter body. Identify them as lifter "A" and lifter "B". (Figure 3)

DISASSEMBLY

1. Hold plunger down with push rod and remove push rod seat retainer with blade of small screwdriver.
2. Remove push rod seat and metering valve lifter "A" (or push rod seat and inertia valve assembly lifter "B"). (Figure 3)
3. Remove plunger, ball check valve assembly and plunger spring.
4. Remove ball check valve and spring by prying ball retainer loose from plunger with blade of small screwdriver. (Figure 4)

CLEANING and INSPECTION

Thoroughly clean all parts in cleaning solvent and inspect parts carefully. If any parts are damaged or worn, entire lifter assembly should be replaced. If outside of lifter body is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is scuffed or worn, inspect camshaft lobe. If push rod seat is scuffed or worn, inspect push rod.

NOTE: Do not remove inertia valve and retainer (lifter "B") (Figure 3) from push rod seat. To check valve, shake push rod seat and inertia valve assembly. Valve should move.

REASSEMBLY

1. Place check ball on small hole in bottom of plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on ball. Carefully press retainer into position in plunger with blade of a small screwdriver. (Figure 5)

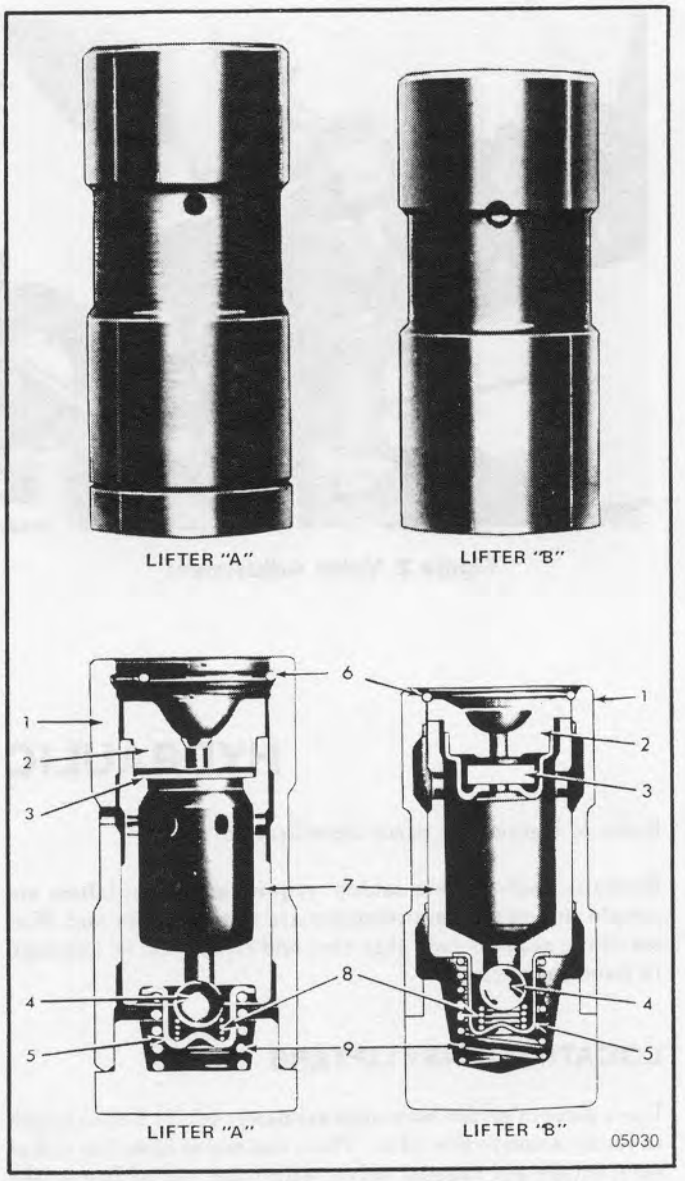
⚠CAUTION

Do not attempt to force or pump the plunger.

3. Place plunger spring over ball retainer and slide lifter body over spring and plunger, being careful that oil feed holes in lifter body and plunger line up.
4. Fill assembly with oil, then insert end of a ⅛" (3mm) drift pin into plunger and press down strongly. At this point, oil holes in lifter body and plunger assembly will be aligned. (Figure 6)
5. Insert a 1/16" (1.5mm) drift pin thru both oil holes to hold plunger down against lifter spring tension. (Figure 6)

NOTE: On lifter "B" (Figure 3), drift pin must not extend inside plunger.

6. Remove ⅛" drift pin and refill assembly with oil.
7. Install metering valve and push rod seat lifter "A" (or push rod seat and inertia valve assembly lifter "B"). (Figure 3)



1 - Lifter Body
2 - Push Rod Seat
3 - Metering Valve (Lifter "A")
Inertia Valve (Lifter "B")
4 - Check Ball
5 - Check Ball Retainer
6 - Push Rod Seat Retainer
7 - Plunger
8 - Check Ball Spring
9 - Plunger Spring

Figure 3. Hydraulic Valve Lifters

8. Install push rod seat retainer, press down on push rod seat and remove 1/16" drift pin from oil holes. Lifter now is completely assembled, filled with oil and ready for installation.

NOTE: Before installing a new lifter, coat bottom of lifter with engine oil.

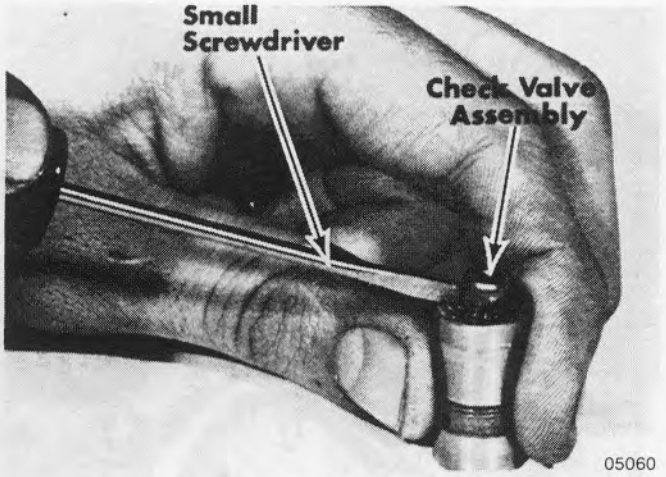


Figure 4. Removing Ball Check Valve

Figure 5. Installing Ball Check Valve

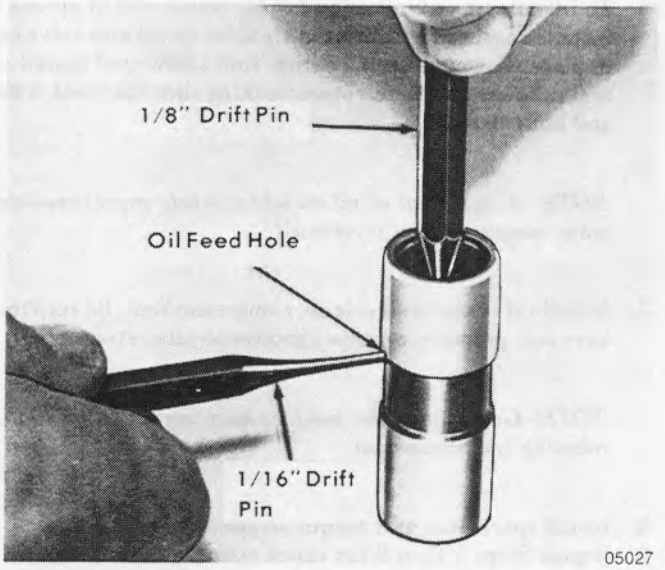


Figure 6. Assembling Hydraulic Lifters

INSTALLATION

1. Install valve lifters.

   NOTE: Whenever valve lifters are being installed, coat bottom of valve lifters with engine oil.

2. Install push rod covers, using new gaskets, and torque to specifications.
3. Install distributor, positioning rotor to No. 1 cylinder position, then connect primary lead at coil.
4. Install distributor cap and high tension wires.
5. Install and adjust valves.
6. Adjust ignition timing, carburetor idle speed and mixture.

VALVE STEM OIL SEAL and/or VALVE SPRING

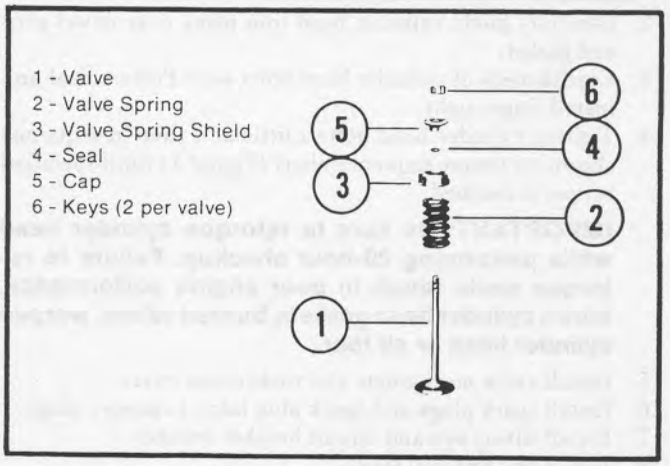


Figure 7. Valve Spring and Related Parts

REPLACEMENT

1. Remove rocker arm cover.
2. Remove spark plug, rocker arm and push rod on cylinder to be serviced.
3. Place piston for that cylinder at TDC to prevent valves from dropping into combustion chamber.

   NOTE: A tool to apply air to cylinder is available thru local jobbers. Engines use tapered spark plugs.

4. Compress valve spring with Tool J-5892 and remove valve keys, valve spring cap, spring shield and valve spring. (Figure 8)
5. Remove valve stem oil seal.

6. To install, set valve spring (close, coiled end of spring is installed against cylinder head), valve shield and valve cap in place. Compress spring with Tool J-5892 and install oil seal in lower groove of stem, making sure that seal is flat and not twisted.

   NOTE: A light coat of oil on seal will help prevent twisting when compressor tool is released.

7. Install valve keys and release compressor tool. Be sure that keys seat properly in upper groove of valve stem.

   NOTE: Grease may be used to hold keys in place while releasing compressor tool.

8. Install spark plug and torque to specifications.
9. Repeat Steps 2 thru 8 for other cylinders.
10. Install and adjust valve mechanism.

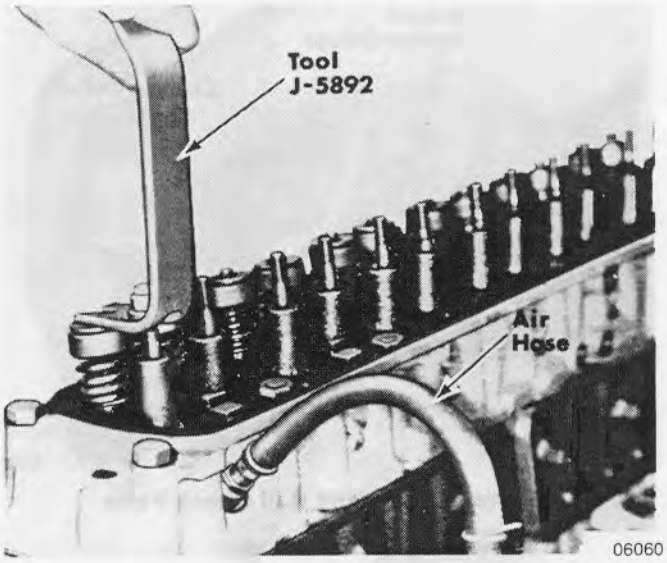


Figure 8. Compressing Valve Spring

CYLINDER HEAD

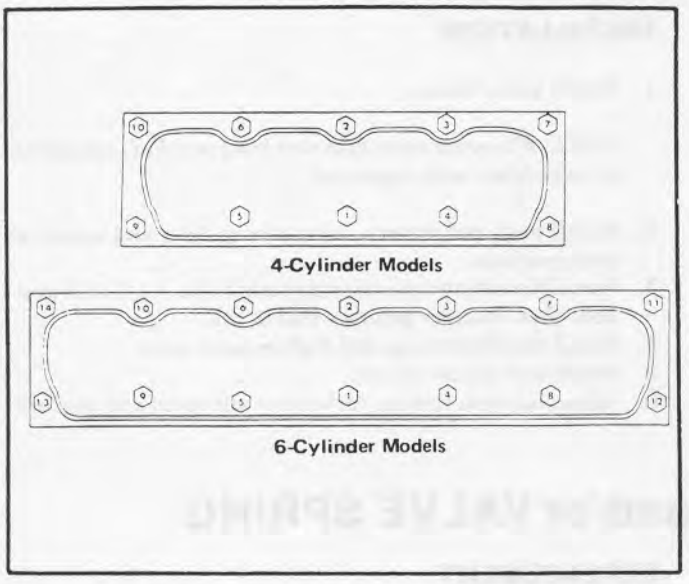


Figure 1. Cylinder Head Torque Sequence

REMOVAL

1. Drain water from cylinder block and manifold.
2. Disconnect fuel line support clamps and remove fuel line.
3. Remove exhaust manifold.
4. Disconnect cooling hoses.
5. Disconnect wire from temperature sending unit (located in water distribution housing) and remove water distribution housing from cylinder head.
6. Disconnect wires from coil and remove coil.
7. Remove circuit breaker bracket and lifting eye.
8. Disconnect spark plug leads from spark plugs and remove all spark plugs from cylinder head.
9. Remove rocker arm cover and valve mechanism.
10. Remove cylinder head bolts, cylinder head and gasket. Handle cylinder head carefully to prevent damage.

INSTALLATION

⚠CAUTION

Gasket surfaces on both head and block must be clean of any foreign matter and free of nicks and/or deep scratches. Cylinder bolt threads in block, and threads on cylinder head bolt must be cleaned. Dirt will affect bolt torque. DO NOT use gasket sealer on composition steel asbestos gaskets.

1. Place new gasket in position over dowel pins.

⚠CAUTION

DO NOT use steel automotive type cylinder head gaskets. Use only Quicksilver replacement parts.

2. Carefully guide cylinder head into place over dowel pins and gasket.
3. Coat threads of cylinder head bolts with Perfect Seal and install finger-tight.
4. Tighten cylinder head bolts a little at a time in sequence shown on torque sequence chart (Figure 1) until specified torque is reached.

   IMPORTANT: Be sure to retorque cylinder head while performing 20-hour checkup. Failure to retorque could result in poor engine performance, blown cylinder head gaskets, burned valves, warped cylinder head or all four.

5. Install valve mechanism and rocker arm cover.
6. Install spark plugs and spark plug leads to proper plugs.
7. Install lifting eye and circuit breaker bracket.
8. Install coil and coil leads.
9. Install water distribution housing to cylinder head and connect temperature sending unit lead.
10. Connect cooling hoses to water distribution housing.
11. Install exhaust manifold.
12. Install fuel line and fuel line support clamps.

CYLINDER HEAD and VALVE CONDITIONING

DISASSEMBLY

1. Remove cylinder head.
2. Compress the valve springs with Tool J-8062 (Figure 2) and remove valve keys. Release compressor tool and remove spring caps, spring shields and valve springs. Remove oil seals from valves.
3. Remove valves from cylinder head and place them in a rack in their proper sequence for later assembly in their original positions.

CLEANING

1. Clean all carbon from combustion chambers and valve ports with Tool J-8089. (Figure 3)
2. Thoroughly clean valve guides with Tool J-8101. (Figure 4)
3. Clean all sludge from push rods, rocker arms and push rod guides.
4. Clean valve stems and valve heads on a buffing wheel.
5. Clean cylinder head gasket mating surface.

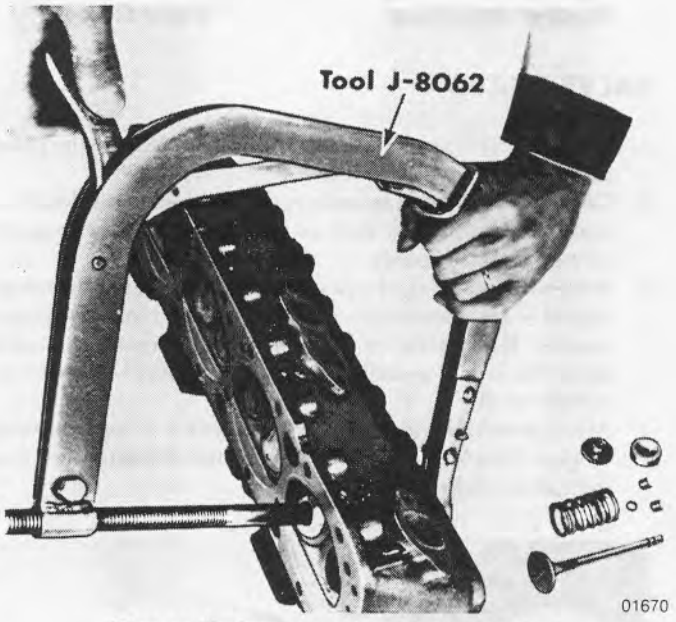


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Figure 2. Compressing Valve Spring

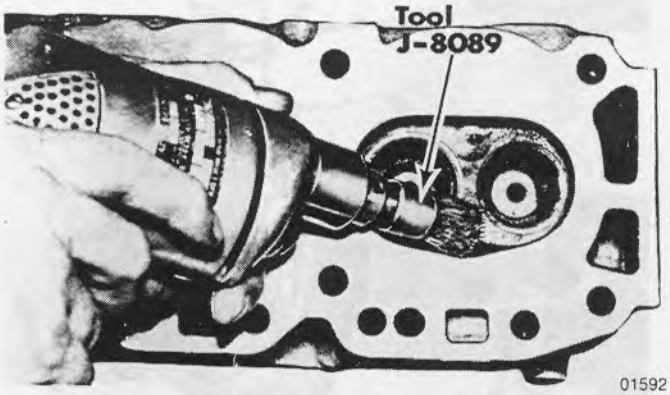

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Figure 3. Cleaning Combustion Chambers

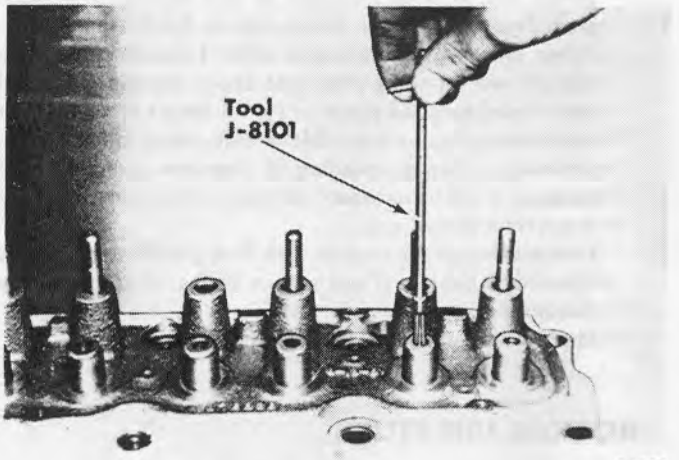

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Figure 4. Cleaning Valve Guides

INSPECTION

1. Inspect cylinder head gasket surface for flatness. If not within specifications, resurface or replace cylinder head.
2. Inspect cylinder head for cracks in exhaust ports, combustion chambers or external cracks to water chamber.
3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and may cause valve breakage. Insufficient clearance will result in noisy and sticky valves and disturb smooth engine operation.

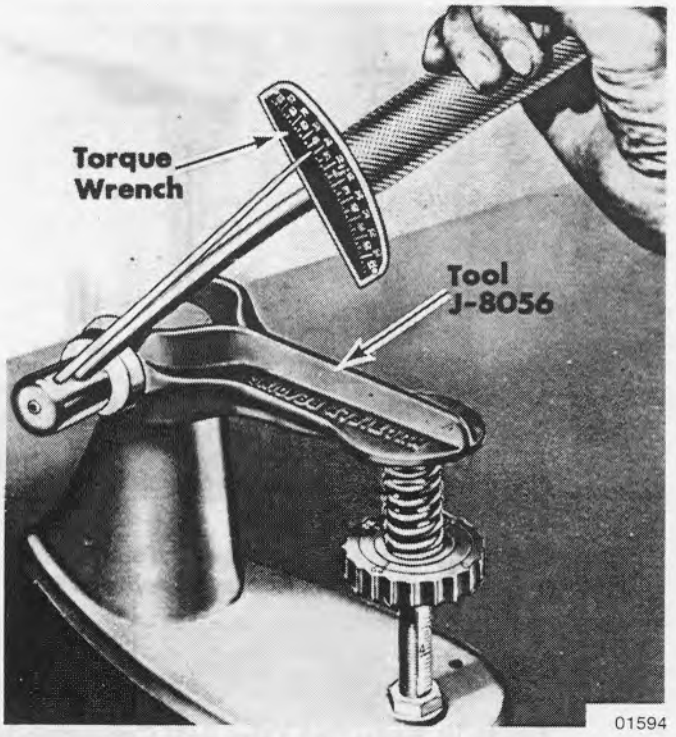

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Figure 5. Checking Valve Spring Tension

4. Measure valve stem clearance as follows: Clamp a dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side-to-side (crosswise to head) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide. With valve head dropped about 1/16" (1.5mm) off valve seat, move stem of valve from side-to-side, using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves as outlined.
5. Check valve spring tension with Tool J-8056 spring tester. (Figure 5) Replace if not within 10 lbs. of specified load (without dampers).
6. Inspect rocker arm studs for wear or damage.

ROCKER ARM STUDS

Rocker arm studs with damaged threads or with loose fit in cylinder heads should be replaced with new, oversize studs. Studs may be installed after reaming holes as follows:

1. Drain water from cylinder block.
2. Remove old stud by placing Tool J-5802-01 over stud, installing nut and flat washer and removing stud by turning nut. (Figure 6)
3. Ream hole for oversize stud with Tool J-5715 for .003" oversize or Tool J-6036 for .013" oversize. (Figure 7)

IMPORTANT: Do not attempt to install an oversize stud without reaming stud hole.

4. Coat press-fit area of stud with Perfect Seal. Install new stud, using Tool J-6880 as a guide. Gauge should bottom on head. (Figure 8)

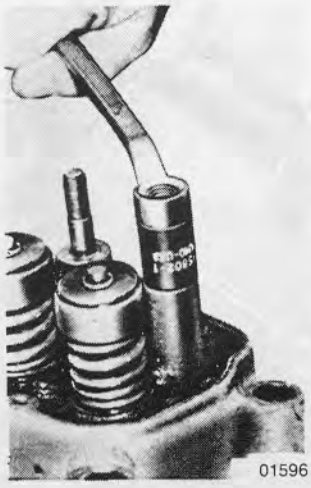


Figure 6. Removing Rocker Arm Stud

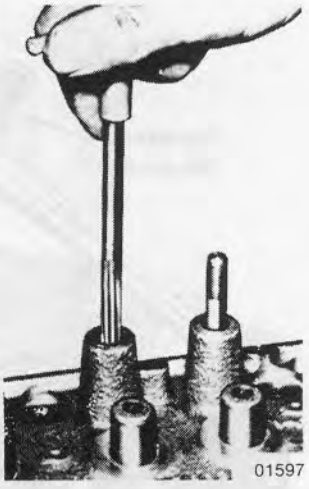


Figure 7. Reaming Rocker Arm Stud Bore

VALVE GUIDE BORES

Valves with oversize stems are available (see specifications). To ream valve guide bores for .015" oversize valves, use Tool J-5830-2 and for standard, use Tool J-8814. (Figure 9)

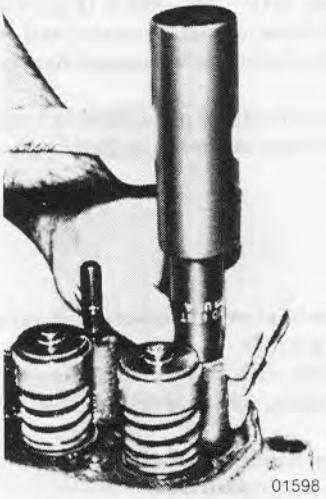


Figure 8. Installing Rocker Arm Stud

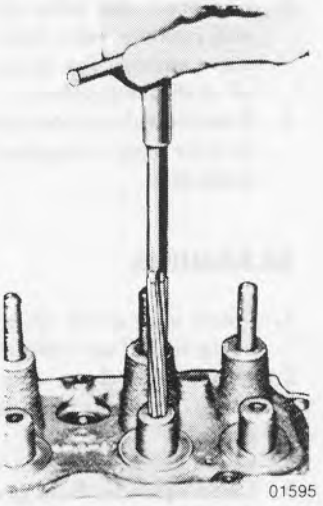


Figure 9. Reaming Valve Guide

VALVE SEATS

1. Valves must seat perfect for the engine to deliver the power and performance built into it.
2. Good contact between each valve and its seat in head is a must to ensure that heat in valve head will be properly carried away (cooled).
3. Recommendations of equipment manufacturer for reseating valve seats should be carefully followed to attain proper results. Regardless of what type of equipment is used, however, it is essential that valve guide bores be free from carbon or dirt.
4. After grinding valve seat, check seat for out-of-round. (Figure 10) (Max. is .002" [.05mm] out-of-round with total indicator reading.)

Figure 10. Measuring Valve Seat Concentricity

VALVES

Pitted valves can be refaced to proper angle (Figure 11) thus ensuring correct relation between head and stem on valve refacing mechanism. Valve stems, which show excessive wear or valves that are warped excessively, should be replaced. When a valve head (warped excessively) is refaced, a knife edge will be ground on part or all of valve head due to amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition from heat localizing on this knife edge. If edge of valve head is less than 1/32" (.8mm) thickness after grinding, replace valve.

Recommendations of equipment manufacturer for refacing valves should be carefully followed to obtain best results.

IMPORTANT: Only extreme end of valve stem is hardened to resist wear. Do not grind end of stem excessively.

1. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks about ¼" (6mm) apart across valve face, place valve in cylinder head and give valve ½-turn in each direction while exerting firm pressure on head of valve.
2. Remove valve and check face carefully. If all pencil marks have not been removed at point of contact with valve seat, it will be necessary to repeat refacing operation and again recheck for proper seating.
3. Grind and check remaining valves in same manner.

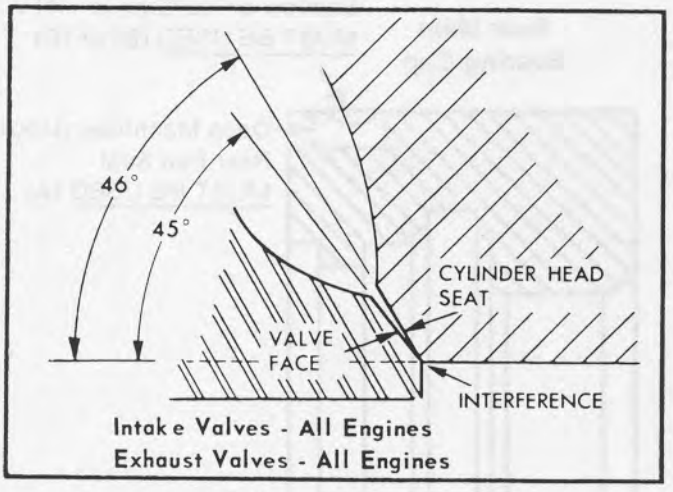


Figure 11. Relation of Valve and Seat Angles

REASSEMBLY

1. Insert valve in proper port.
2. Using compressor tool, assemble valve spring and related parts as outlined in "Valve Stem Oil Seal and/or Valve Spring". (Steps 6 and 7)
3. Install remaining valves.
4. Check each vale stem oil seal by placing a vacuum cup or similar device over end of valve stem and against cap. Operate vacuum cup and make sure that no air leaks past seal.
5. Check installed height of valve springs with scale. (Figure 13) Measure from top of spring seat to top of valve spring shield. If this exceeds specified height, install a valve spring seat shim approximately 1/16" (1.5mm) thick. At no time should spring be shimmed to give an installed height under minimum specified.

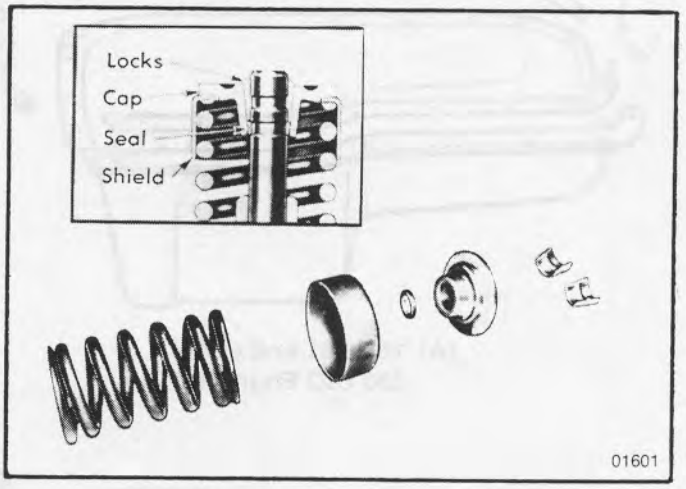


Figure 12. Valve Spring Installation

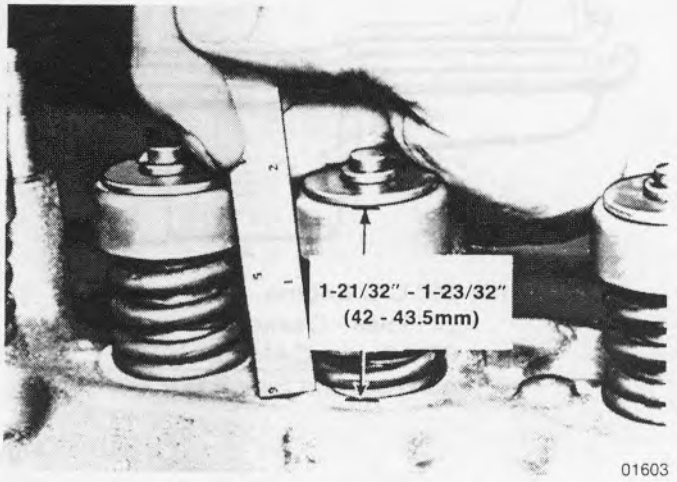


Figure 13. Checking Valve Spring Installed Height

OIL PAN

REMOVAL

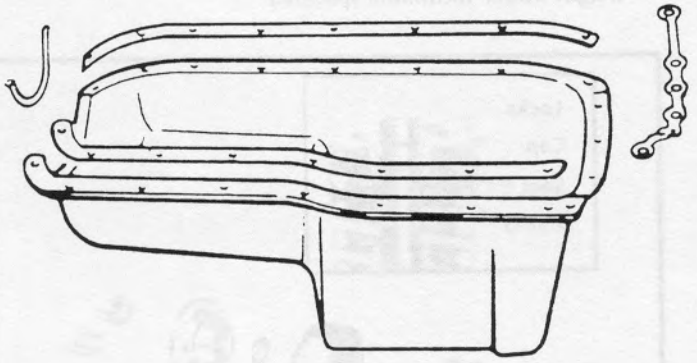
1. Disconnect battery.

   NOTE: Removal of engine from boat may be required.

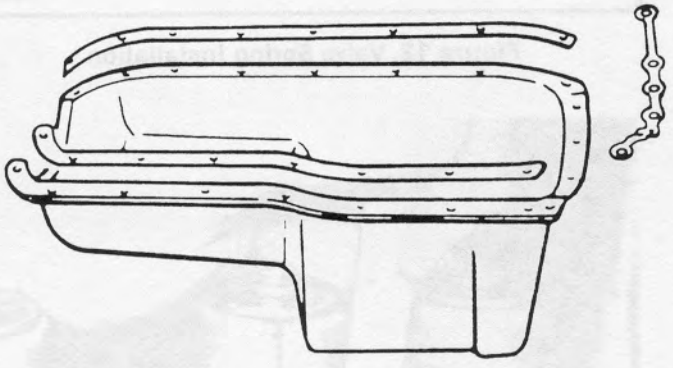
2. Drain engine oil.
3. Remove starter motor.
4. Remove oil pan screws, oil pan, side and end gaskets.

INSTALLATION

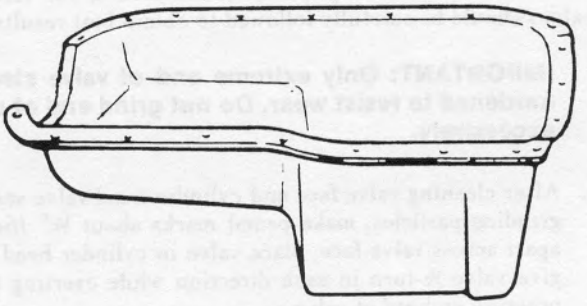
1. Thoroughly clean all gasket sealing surfaces.
2. Refer to Figure 14 for installation.
3. Install oil pan.
4. Install starter motor.
5. Fill crankcase with oil.
6. Connect battery.



(A) 153, 181 and early 250 CID Engines



(B) 250 CID Engine
24 Holes - Gasket or RTV Sealer CAN BE USED on Front and Side Rails



(C) 250 CID Engine
16 Holes - RTV MUST BE USED on Front and Side Rails

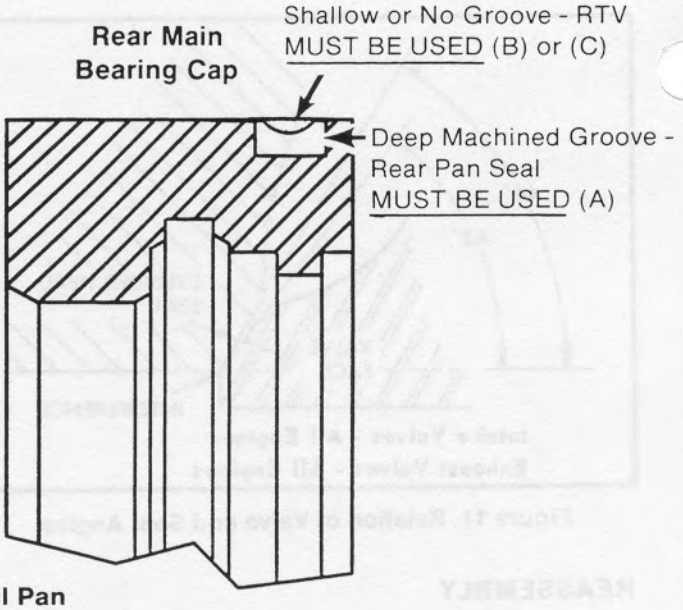


Figure 14. Oil Pan

OIL PUMP

Oil pump consists of 2 gears and a pressure regulator valve enclosed in a 2-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft. A baffle is incorporated on pickup screen to eliminate pressure loss. Use Figure 15 for reference.

REMOVAL

1. Remove oil pan.
2. Remove flange mounting bolts and pickup pipe bolt, then remove pump and screen as an assembly.

DISASSEMBLY

IMPORTANT: DO NOT remove pickup screen and pipe assembly unless replacement is necessary. Loss of press fit condition could result in air leak and loss of oil pressure.

1. Remove pump cover attaching screws, pump cover and pump cover gasket.

IMPORTANT: Mark gear teeth so they may be re-assembled with same teeth indexing.

2. Remove idler gear and drive gear and shaft from pump body.
3. Remove pressure regulator valve retaining pin, pressure regulator, spring and valve.
4. If pickup screen and pipe assembly need replacing, mount pump in a soft-jawed vise and extract pipe from pump.

IMPORTANT: Do not disturb pickup screen on pipe which is serviced as an assembly.

CLEANING and INSPECTION

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear.
4. Check drive gear shaft for looseness in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen, pipe or relief grommet.
7. Check pressure regulator valve for fit.

NOTE: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replace entire oil pump assembly.

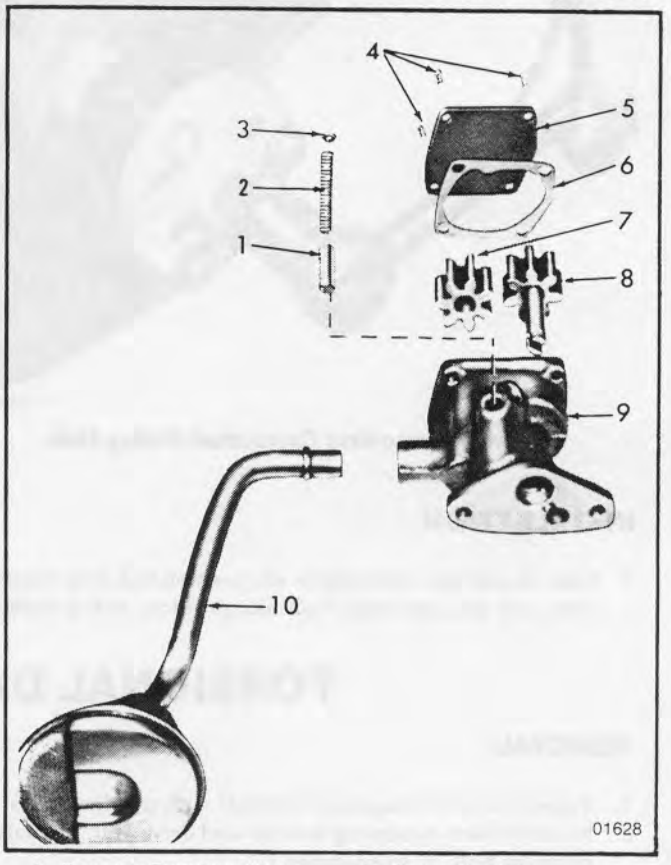
REASSEMBLY

1. If pickup screen and pipe assembly was removed, replace with a new part. Loss of press fit condition could result in air leak and loss of oil pressure. Mount pump in soft-jawed vise and apply Perfect Seal to end of pipe with Tool J-8369. Tap pipe in place with plastic hammer.

⚠CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to bottom of oil pan when oil pump is installed.

2. Install pressure regulator valve spring and retaining pin.
3. Install drive gear and shaft in pump body.
4. Install idler gear in pump body with smooth side of gear toward pump cover opening, aligning teeth marked in disassembly.
5. Install pump cover with new gasket and torque attaching screws to specifications.
6. Turn drive shaft by hand to check for smooth operation.



1 - Pressure Regulator Valve
2 - Pressure Regulator Spring
3 - Retaining Pin
4 - Screws
5 - Pump Cover
6 - Cover Gasket
7 - Idler Gear
8 - Drive Gear and Shaft
9 - Pump Body
10 - Pickup Screen and Pipe

Figure 15. Oil Pump

INSTALLATION

1. Align oil pump drive shafts to match with distributor tang, then install oil pump to block, positioning flange over distributor lower bushing. Use no gasket.

IMPORTANT: Oil pump should slide easily into place. If not, remove and reposition slot to align with distributor tang.

2. Install oil pump bolts and tighten securely.
3. Install oil pan.

CRANKSHAFT PULLEY (153 CID)

REMOVAL

1. Support front of engine (if in boat) with overhead hoist.
2. Remove front mounting bracket and drive belt. Remove crankshaft pulley from pulley hub.
3. Install puller Tool J-6978-E to pulley hub and remove hub. (Figure 1) Remove puller tool.

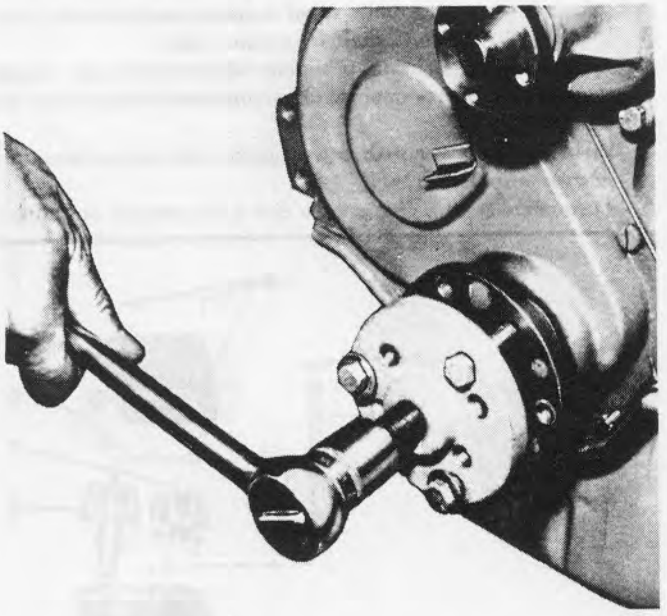


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Figure 1. Removing Crankshaft Pulley Hub

INSTALLATION

1. Coat oil seal lip with engine oil, position hub over crankshaft and key and start hub into position with a mallet. Using Tool J-5590, strike hub until it bottoms against crankshaft gear.

IMPORTANT: Crankshaft extends slightly thru hub, and a tool is necessary to drive hub completely into bottomed position.

2. Install pulley onto hub.

NOTE: There are two 3/8" holes and one 5/16" hole that must be matched on hub in order to properly position timing mark. (Figure 2)

3. Install drive belt and adjust tension.
4. Install front mounting bracket.

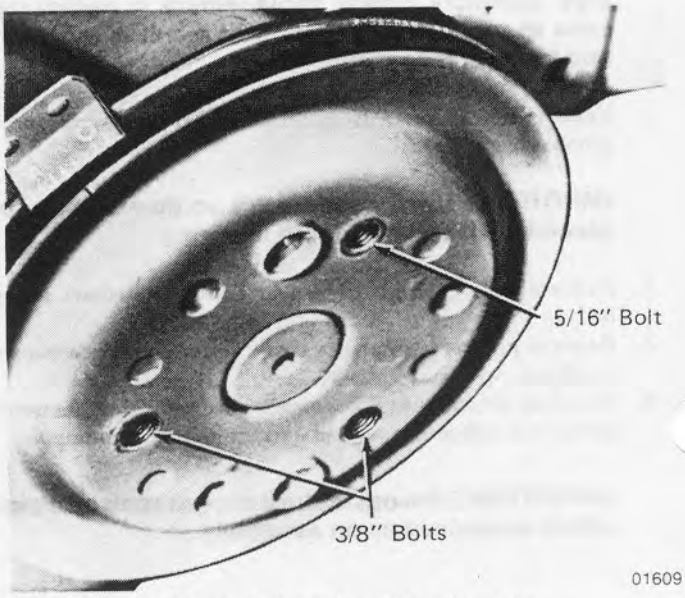

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Figure 2. Install Pulley to Hub

TORSIONAL DAMPER (181/250 CID)

REMOVAL

1. Support front of engine (if in boat) with overhead hoist.
2. Remove front mounting bracket and drive belt. (Remove retaining bolt, if so equipped.)
3. Install Tool J-6978-E to balancer and turn puller screw to remove damper. (Figure 3) Remove tool from damper.

⚠CAUTION

Inertia weight section of torsional damper is assembled to hub with rubber type material. Installation procedures (with proper tool) must be followed or movement of inertia weight section on hub will upset tuning of torsional damper.

INSTALLATION

1. Coat front cover oil seal lip with engine oil.

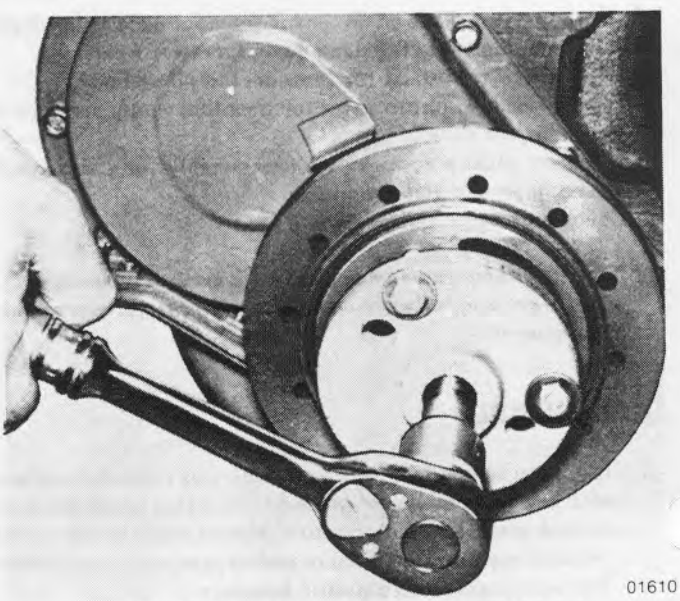

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Figure 3. Removing Harmonic Balancer

2. Attach damper installer Tool J-22197 to damper as shown in Figure 4.
3. Position damper on crankshaft and drive into position until it bottoms against crankshaft gear.
4. Remove installation tool.
5. Install drive belt and adjust tension.
6. Install front mounting bracket.

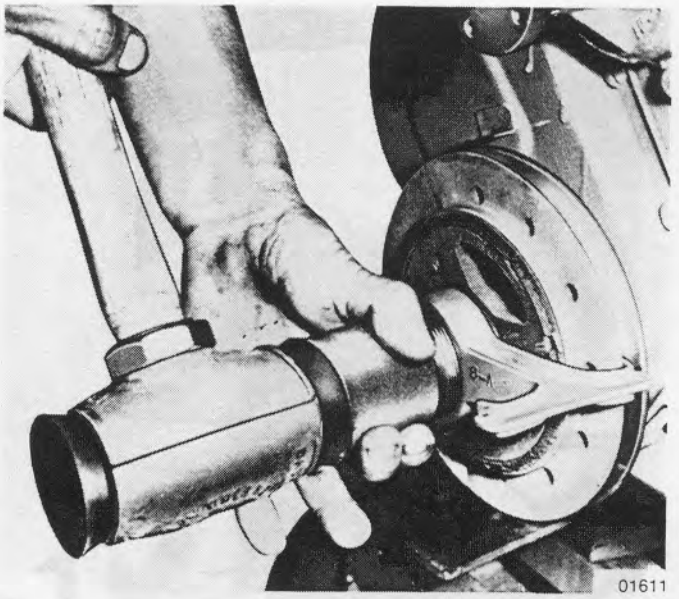

Figure 4. Installing Harmonic Balancer

CRANKCASE FRONT COVER

REMOVAL

1. Remove oil pan.
2. Remove crankshaft pulley and hub or damper.
3. Remove crankshaft front cover attaching screws, cover and gasket.

INSTALLATION

1. Clean gasket surfaces on block and crankcase front cover.
2. Install centering Tool J-23042 in crankcase front cover seal. (Figure 5)
3. Coat gasket with gasket sealer and place in position on cover, then install crankcase front cover to block and torque to specifications.
4. Remove centering tool.

IMPORTANT: Use only centering tool to align crankcase front cover so that crankshaft hub or damper installation will not damage seal and to position seal to seal evenly around damper or hub surface.

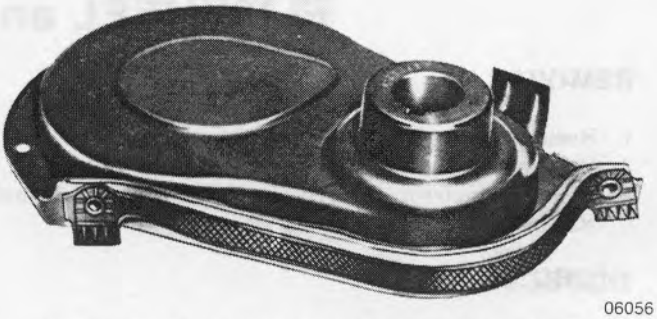

Figure 5. Centering Tool (J-23042) In Cover

5. Install crankshaft hub and/or damper.
6. Install oil pan.

OIL SEAL (FRONT COVER)

REPLACEMENT

With Cover Removed

1. With cover removed, pry old seal out of cover from front with large screwdriver.
2. Install new seal so that lip of seal is toward inside of engine and drive seal into position with Tool J-23042. (Figure 6)

IMPORTANT: Support cover at sealing area.

Without Cover Removed

1. With crankshaft pulley and hub or damper removed, pry old seal out of cover from front with large screwdriver, being careful not to damage seal surface on crankshaft.
2. Install new seal so that lip of seal is toward inside of engine and drive seal into position with Tool J-23042. (Figure 7)

Figure 6. Installing Oil Seal (Cover Removed)

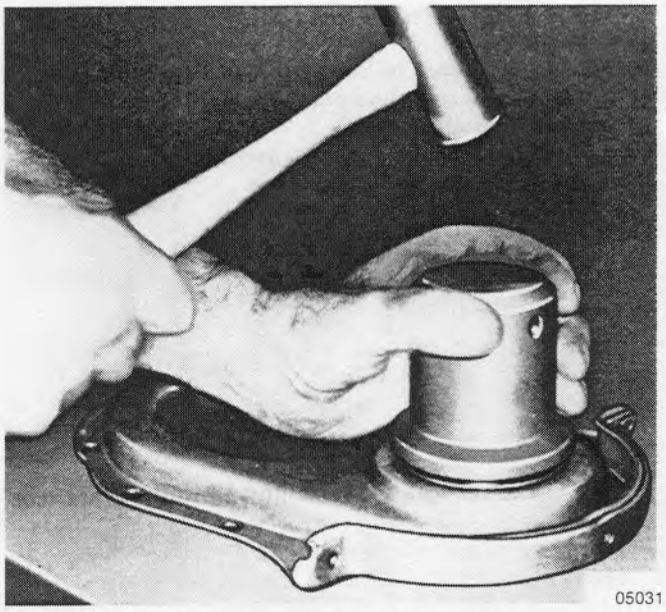

Figure 7. Installing Oil Seal (Cover Installed)

FLYWHEEL and ENGINE COUPLER

REMOVAL

1. Remove engine from boat.
2. Remove bell housing.
3. Remove coupler by removing retaining nuts and washers.
4. Remove flywheel.

INSPECTION

1. Check engine coupling assembly.
2. Check flywheel ring gear for worn or missing teeth.

INSTALLATION

1. Install flywheel. Line up dowel hole in flywheel with dowel hole in crankshaft flange and set flywheel in place on studs. (Figure 8)
2. Place drive coupling on studs and install washers and lock nuts. Torque nuts to specifications with Torque Wrench and Adaptor (91-35547).
3. Install bell housing.
4. Lubricate coupler splines with 2-4-C Multi-Lube and install engine in boat.
5. Check engine alignment.

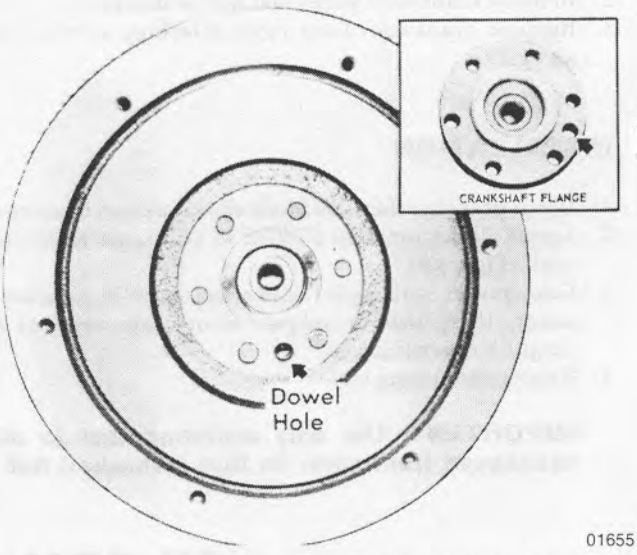

Figure 8. Flywheel Position on Crankshaft Flange

OIL SEAL (REAR MAIN)

REPLACEMENT

Rear main bearing oil seal can be replaced (both halves) without removing crankshaft.

IMPORTANT: Always replace upper and lower seal as a unit. Install with lip facing toward inside of engine. Where seal has 2 lips, install lip with helix toward front of engine.

1. With oil pan removed, remove rear main bearing cap.
2. Remove oil seal from rear main bearing cap by prying from bottom with small screwdriver.

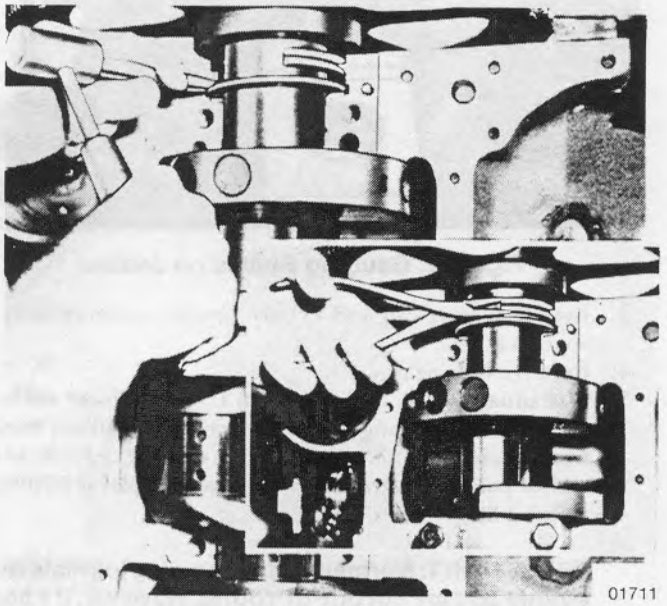

Figure 9. Removing Oil Seal (Upper Half) Typical

3. Lubricate lip of new seal with engine oil. Keep oil off parting line surface, as this is treated with glue. Insert seal in cap and roll seal into place with finger and thumb, using light pressure so seal tangs at parting line do not cut bead on back of seal.

IMPORTANT: Later seals come with an installation tool. Follow instructions supplied with new seal.

4. To remove upper half of seal, use small hammer and tap brass pin punch on one end of seal until it protrudes far enough to be removed with pliers. (Figure 9)

IMPORTANT: Always wipe crankshaft surface clean before installing new seal.

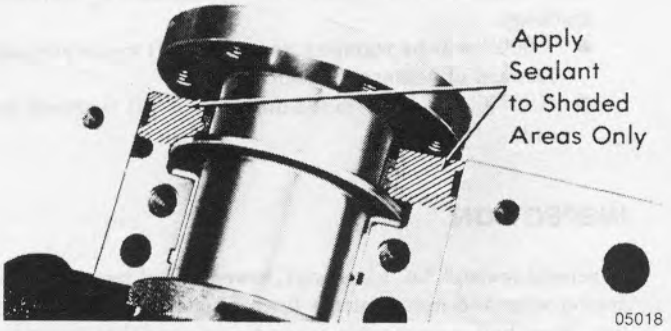

Figure 10. Sealing Bearing Cap and Block

5. Lubricate lip of new seal with engine oil. Keep oil off parting line surface. Gradually push with a hammer handle (while turning crankshaft) until seal is rolled into place (similar to installing a main bearing). Be careful that seal tangs at parting line do not cut bead on back of seal. Use sealer at parting line on rear main bearing cap half of seal.
6. Apply Perfect Seal to cylinder block in seal area. (Figure 10)
7. Install rear main bearing cap (with new seal) and torque to specifications.
8. Install oil pan.

MAIN BEARINGS

1. Main bearings are precision insert type and do not utilize shim for adjustment. If clearances are found to be excessive, a new bearing (both upper and lower halves) will be required. Bearings are available in standard size and undersize.
2. Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For example, one half of a standard insert with one half of a .001" undersize insert may be found, which will decrease clearance .0005" from using a full standard bearing.
3. When a production crankshaft cannot be precision fitted by this method, it then is ground .009" undersize on main journals only. A .009" undersize bearing and .010" undersize bearing may be used for precision fitting in same manner as previously described. Any engine, fitted with a .009" undersize crankshaft, will be identified by following markings.
   - ".009" will be stamped on crankshaft counterweight forward of centermain journal.
   - No. "9" will be stamped on block at left front oil pan rail.

INSPECTION

In general (except No. 1 bearing), lower half of bearing shows greater wear and most distress from fatigue. If, upon inspection, lower half is acceptable, it can be assumed that upper half also is satisfactory. If lower half shows evidence of wear or damage, replace both upper and lower halves. Never replace one half without replacing other half. Typical bearing failures are shown under "General".

CHECKING CLEARANCE

To obtain most accurate results, use Plastigage (or its equivalent), a wax-like plastic material which will compress evenly between bearing and journal surfaces without damaging either surface.

With engine upside down, crankshaft will rest on upper bearings, and total clearance can be measured between lower bearing and journal.

IMPORTANT: To assure proper seating of crankshaft, torque all bearing cap bolts as specified. In addition, before checking fit of bearings, wipe surface of crankshaft journal and face and back of bearing clean of oil.

1. Starting with rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.
2. Place piece of gauging plastic the full width of bearing (parallel to crankshaft) on journal. (Figure 1)

IMPORTANT: Do not rotate crankshaft while the gauging plastic is between bearing and journal.

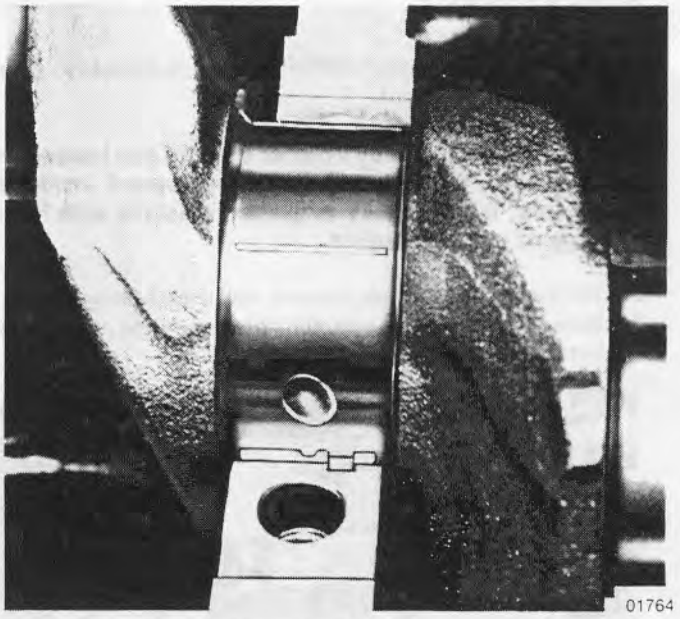

Figure 1. Gauging Plastic on Journal

3. Install bearing cap and evenly torque retaining bolts to specifications.
4. Remove bearing cap.
5. A graduated scale (correlated in thousandths of an inch) exists on edge of gauging plastic envelope. Without removing gauging plastic, measure its compressed width (at widest point) with graduations on gauging plastic envelope. (Figure 2)

IMPORTANT: Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" [.025mm] max.), be sure to fit to maximum diameter

Figure 2. Measuring Gauging Plastic

of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer if flattened gauging plastic indicates more than .001" difference.

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace insert. Always replace both upper and lower insert as a unit.
7. A standard .001" or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft so that no excessive drag exists.
9. Measure crankshaft end play as outlined under "Crankshaft".
10. Install new rear main bearing oil seal in cylinder block and main bearing cap.

MAIN BEARING REPLACEMENT

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct-size, main bearings with oil and install in cylinder block and main bearing caps. Check clearance.
4. Install crankshaft.

CONNECTING ROD BEARINGS

Connecting rod bearings are precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Bearings are available in standard size and undersize.

INSPECTION and REPLACEMENT

1. Remove connecting rod cap and bearing.
2. Inspect bearing for evidence of wear or damage. (Defective bearings should not be installed.) Typical bearing failures are shown under "General".
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications and new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with Plastigage or equivalent.

IMPORTANT: If bearing is being fitted to out-of-round crankpin, be sure to fit maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001", interference between bearing and crankpin will result in rapid bearing failure.

a. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft). (Figure 3)
b. Install bearing connecting rod and cap.
c. Install bearing cap and torque nuts evenly to specifications.

IMPORTANT: Do not turn crankshaft with gauging plastic installed.

d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at widest point. (Figure 2)

6. If clearance exceeds specifications, select a new, correct-size bearing and remeasure clearance.

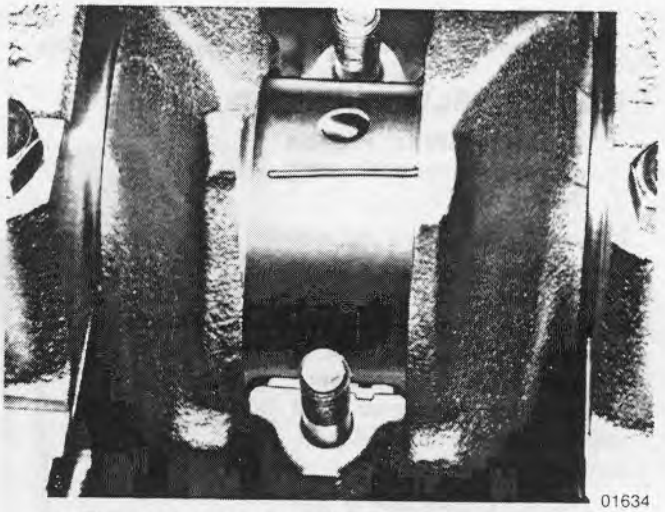
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Figure 3. Gauging Plastic on Crankpin

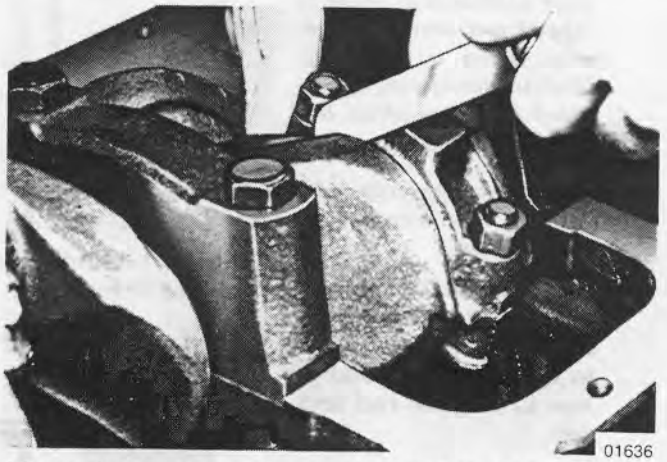
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Figure 4. Measuring Connecting Rod Side Clearance

7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to be sure they have clearance.
9. Measure all connecting rod side clearances between connecting rod and side of crankpin. (Figure 4)

CONNECTING ROD and PISTON ASSEMBLIES

REMOVAL

1. With oil pan, oil pump and cylinder head removed, use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

   IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke and remove cloth and cuttings.

2. Inspect connecting rods and connecting rod caps for cylinder identification. If necessary, mark them.
3. Remove connecting rod cap and install Tool J-5239 (⅜"-24) on bolts. (Figure 1) Push connecting rod and piston assembly out of top of cylinder block.

   NOTE: It will be necessary to turn crankshaft slightly to disconnect some connecting rod and piston assemblies.

DISASSEMBLY (METHOD "1")

IMPORTANT: Piston cannot be reused using Method "1".

If bosses on pistons do not allow piston support Tool J-9510-1 to seat squarely on piston for press operations, modifications to tool are necessary. To allow adequate clearance for these bosses, turn or grind upper portion of tool to dimensions shown in Figure 2.

NOTE: Installation of 181 cubic inch pistons may require additional grinding of support tool beyond dimensions shown in Figure 2. Modification of tool, as described, does not affect tool application on other pistons.

1. Remove connecting rod bearings from connecting rods and caps.

   IMPORTANT: If connecting rod bearings are being reused, place in a rack for reinstallation in original rod and cap.

2. Use piston ring expander to expand rings and remove from pistons.
3. Place connecting rod and piston assembly in arbor press with piston on support Tool J-9510-1 and press piston pin out of connecting rod and piston. (Figure 3)

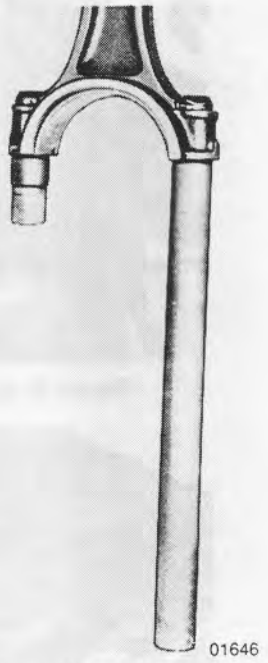


Figure 1. Guide Tool J-5239 Installed

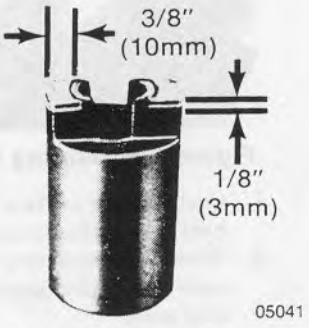


Figure 2. Piston Support Tool J-9510-1

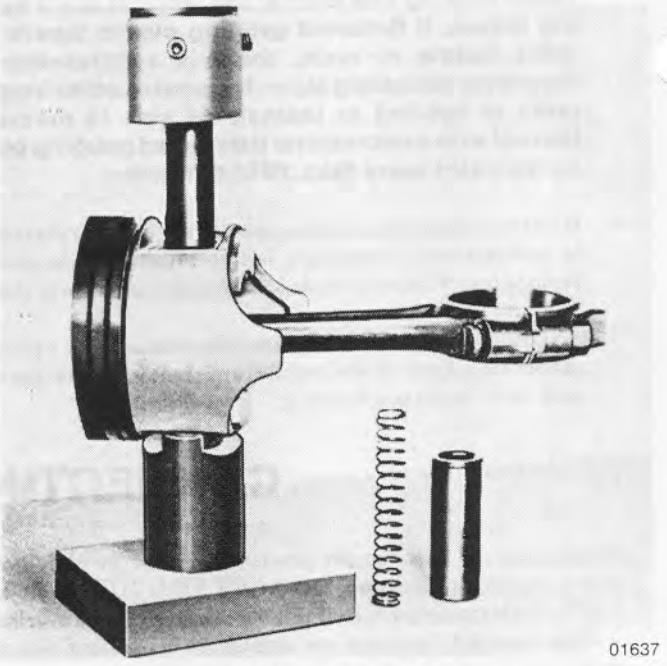
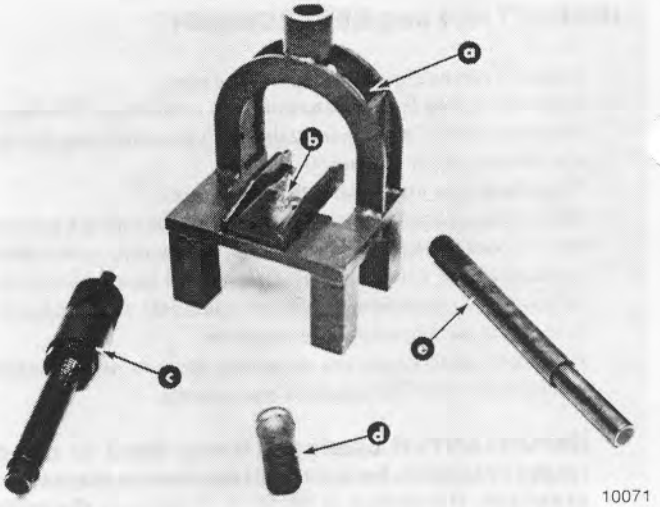


Figure 3. Removing Piston Pin

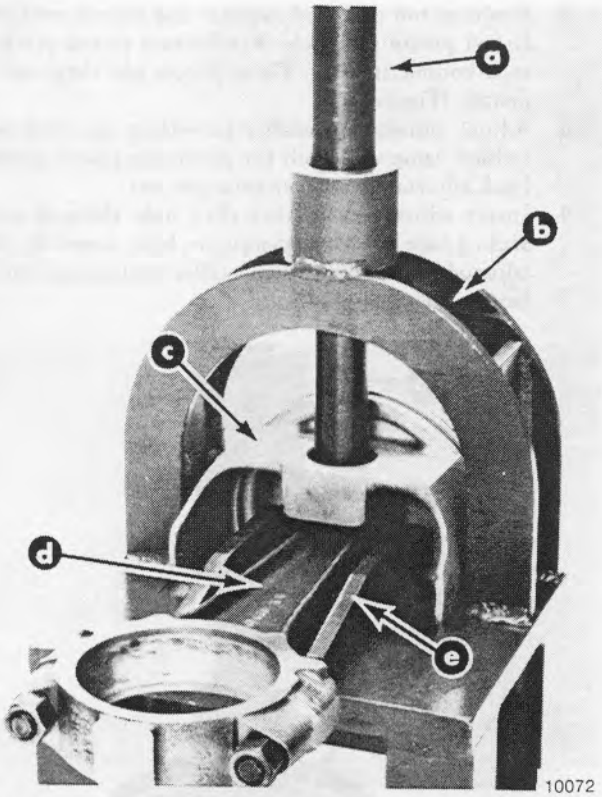


a - Arched Base
b - Rod Support
c - Adjustable Installer
d - Piston Pin Guide
d - Piston Pin Remover

Figure 4. Tool (J-24086-100) Parts Identification

DISASSEMBLY (METHOD "2")

1. Use Tool Kit (J-24086-100), shown in Figure 4.
2. Position connecting rod onto tool rod support with rod support inserted between connecting rod end and piston. Align piston pin with hole located in top of arched base. (Figure 5)
3. Insert pin remover thru hole (located in top of arched base) and into piston pin hole. Press on pin remover to remove piston pin. (Figure 5)



a - Piston Pin Remover
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Figure 5. Removing Piston Pin

CLEANING and INSPECTION

Connecting Rods

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for nicks or cracks. Replace damaged connecting rods.

Pistons

1. Clean varnish from piston skirts and pins with cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with groove cleaner and make sure oil ring holes and slots are clean.
2. Inspect piston for cracked ring lands, skirts or pin bosses, wavy worn ring lands, scuffed or damaged skirts and eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks or burrs which might cause rings to hang up.
4. Measure piston skirt (across centerline of piston pin) and check clearance as outlined under "Cylinder Block".

Piston Pins

1. Piston and piston pin are a matched set and not serviced separately.
2. Pin bores and piston pins must be free of varnish or scuffing. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of .001" (.025mm) wear limit, replace piston and piston pin assembly.

REASSEMBLY (METHOD "1")

⚠CAUTION

DO NOT oil piston pin or connecting rod (Figure 6) before rod end is to be heated for installation.

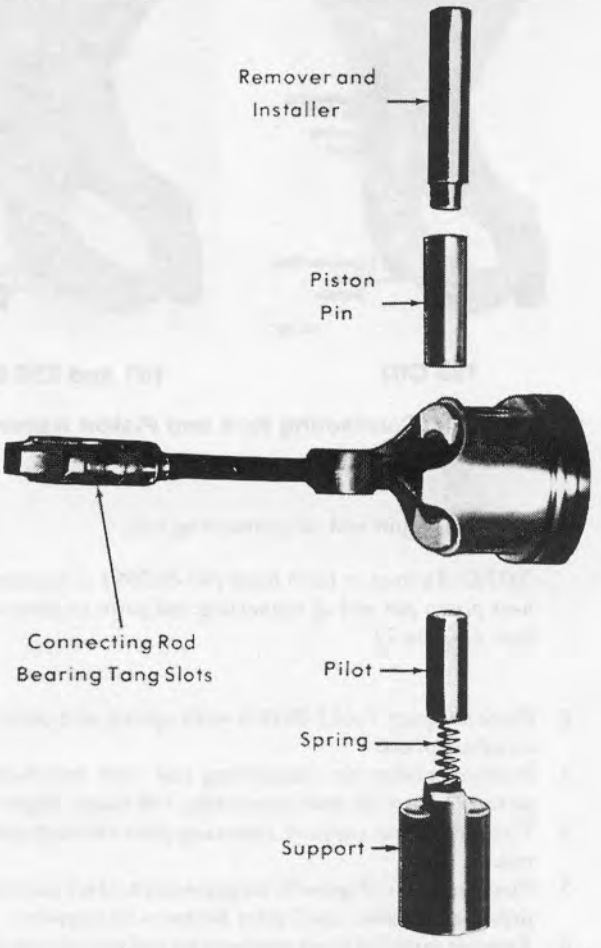


Figure 6. Piston Pin Installation

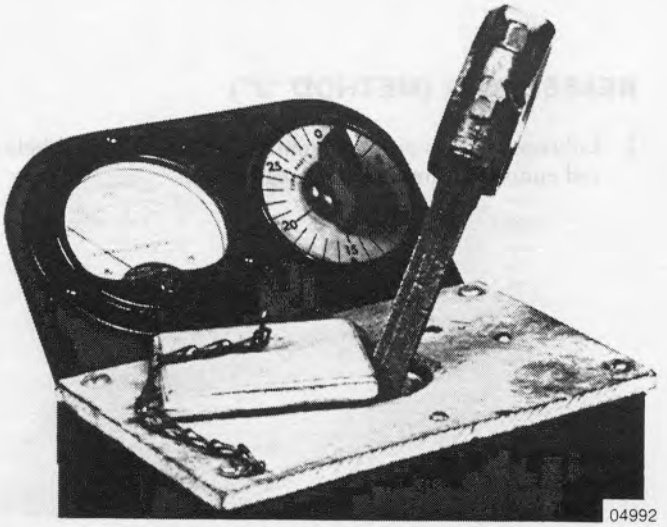
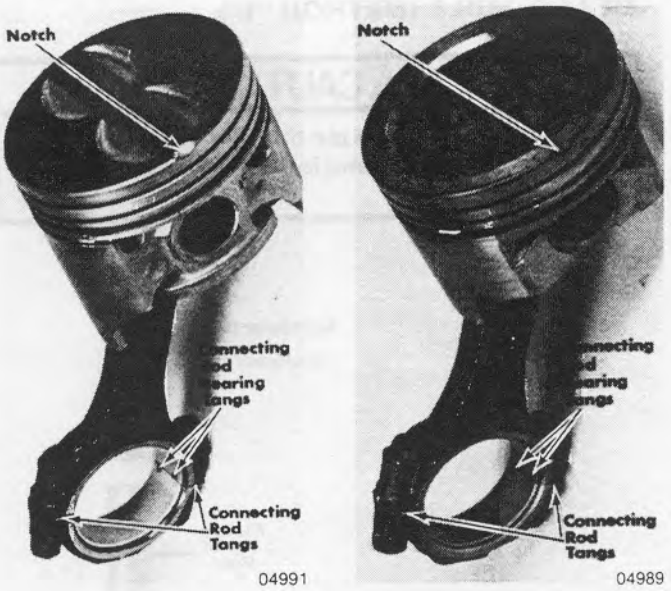


Figure 7. Connecting Rod and Oven



153 CID **181 and 250 CID**

Figure 8. Connecting Rod and Piston Assembly

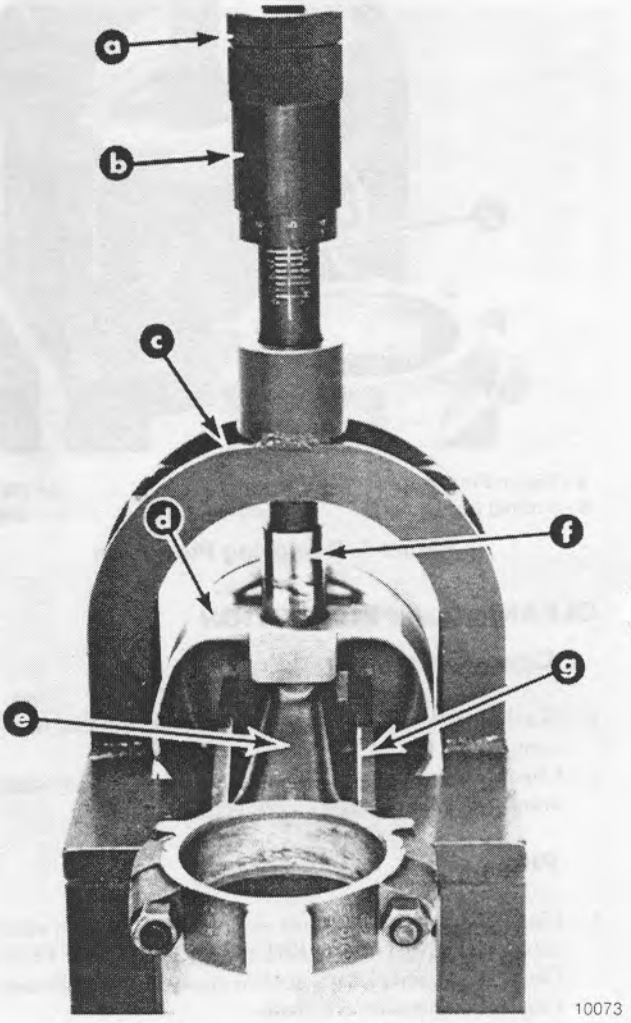
1. Heat piston pin end of connecting rod.

   NOTE: An oven or torch lamp (91-63209) is recommended to heat piston pin end of connecting rod prior to piston installation. (Figure 7)

2. Place support Tool J-9510-1 with spring and pilot in place on arbor press.
3. Position piston on connecting rod with notched side of piston (Figure 8) and connecting rod tangs aligned.
4. Place piston on support, indexing pilot through piston and rod.
5. Place installer (Figure 6) on piston pin, start piston pin and press on installer until pilot bottoms in support.
6. Remove installer from connecting rod and piston assembly and check piston for freedom of movement on piston pin.
7. Allow connecting rod and piston assembly to cool, then oil piston pin.

REASSEMBLY (METHOD "2")

1. Lubricate piston pin, piston pin hole in piston and hole in rod end with a light coat of engine oil.
2. Position rod onto rod support and piston onto rod end. Insert piston pin guide thru bottom piston pin hole and into connecting rod. Place piston pin thru top side of piston. (Figure 9)
3. Adjust adjustable installer to setting specified on chart (which came with tool) for particular piston installation. Lock adjustable installer with jam nut.
4. Insert adjustable installer thru hole (located on top of arched base) and into piston pin hole. Carefully press on adjustable installer until installer bottoms-out on arched base to install piston pin.



a - Jam Nut
b - Adjustable Installer
c - Arched Base
d - Piston
e - Connecting Rod
f - Piston Pin
g - Rod Support

Figure 9. Installing Piston Pin

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure marked side is toward top of piston. Top ring is treated with molybdenum for maximum life. Oil control rings are 3-piece type, consisting of 2 segments (rails) and a spacer.

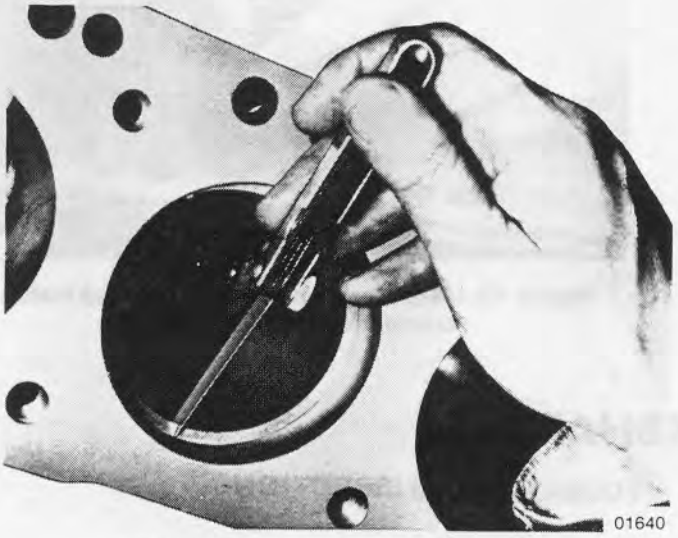


Figure 10. Measuring Ring Gap

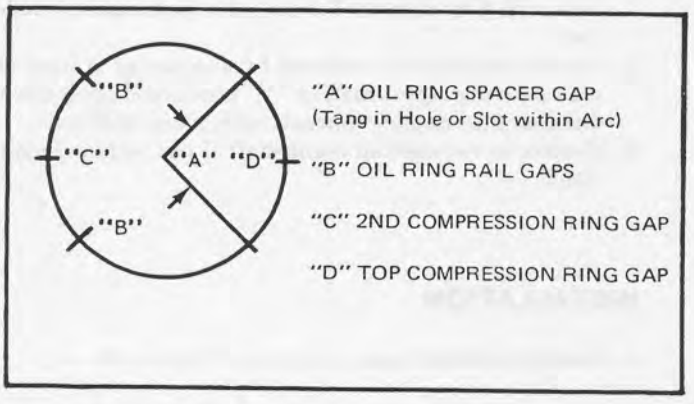


Figure 11. Ring Gap Location

1. Select rings comparable in size to piston being used.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about ¼" (6mm) (above ring travel). Be sure that ring is square with cylinder wall.
3. Measure space or gap between ends of ring with a feeler gauge. (Figure 10)
4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it will be used.
6. Clean and inspect pistons.
7. Slip outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around groove (Figure 12) to make sure that ring is free. If binding occurs at any point, determine cause and, if caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, use a new ring.
8. Install piston rings as shown in Figure 11.
   a. Install oil ring spacer in groove and (except on 250) insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located. (Figure 11)
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex oil ring assembly to make sure that ring is free. If binding occurs at any point, determine cause and, if caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.
   e. Install second compression ring expander, then ring with gaps properly located.
   f. Install top compression ring with gap in correct location.
9. Proper clearance of piston ring in piston ring groove is necessary for proper ring action and to reduce wear. Therefore, when fitting new rings, measure clearances between ring surfaces and groove.

INSTALLATION

IMPORTANT: Cylinder bores must be clean before piston installation. Refer to Step 5, "Cylinder Block - Cylinder Honing."

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install Tool J-5239 (⅜") on connecting rod bolts.

⚠CAUTION

Be sure that ring gaps are properly positioned as previously outlined.

IMPORTANT: Early Model "181", No. 2 connecting rods have a ground recess on camshaft side to provide clearance for fuel pump lobe on camshaft. Be sure that No. 2 connecting rod is installed in same location and position. If connecting rod is replaced, then replace camshaft also, since replacement connecting rods are not ground for clearance, and replacement camshafts have a smaller fuel pump lobe.

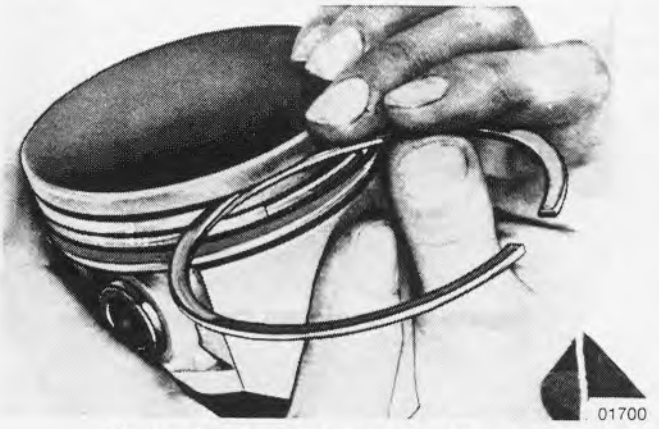


Figure 12. Checking Ring in Groove

4. Install each connecting rod and piston assembly in respective bore. Pistons must have piston notch facing front of engine. Use Tool J-8037 to compress rings. (Figure 13) Guide connecting rod into place on crankshaft journal with Tool J-5239. Use light blows with hammer handle to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.
5. Remove guide tool.
6. Install bearing caps and torque nuts to specification.

NOTE: If bearing replacement is required, refer to "Connecting Rod Bearings".

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted and used pistons in same cylinders from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine.

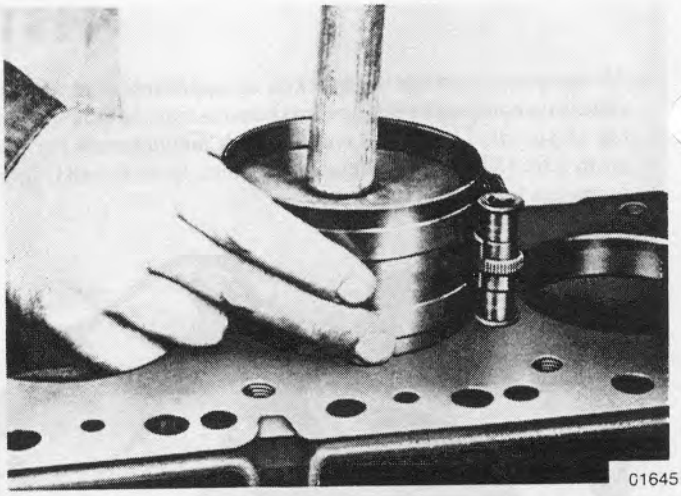


Figure 13. Installing Connecting Rod and Piston Assemblies

CRANKSHAFT

Crankshaft can be removed while engine is disassembled for overhaul or without complete disassembly.

REMOVAL

1. Remove flywheel housing, coupler and flywheel.
2. Remove starter motor.
3. Remove spark plugs.
4. Remove crankshaft pulley or torsional damper.
5. Remove oil pan and oil pump.
6. Remove crankcase front cover.
7. Check connecting rod caps for cylinder number identification. If necessary, mark caps.
8. Remove connecting rod caps and push pistons to top of bores.
9. Remove main bearing caps and lift crankshaft out of cylinder block.
10. Remove rear main bearing oil seal and main bearings from cylinder block and main bearing caps.
11. Remove crankshaft gear as shown in Figure 1A.

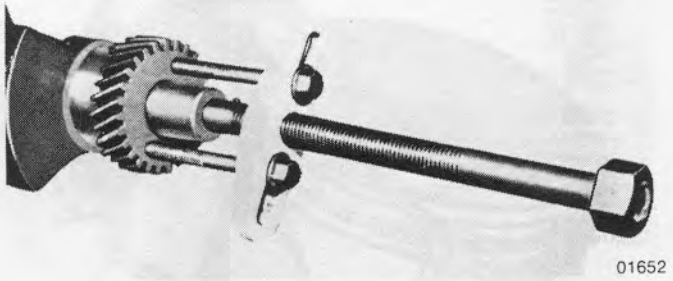


Figure 1A. Removing Crankshaft Gear

CLEANING and INSPECTION

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure dimensions of main bearing journals and crankpins with a micrometer for out-of-round, taper or undersize.
3. Check crankshaft for run-out by supporting at front and rear main bearing journals in "V" blocks and check at front and rear intermediate journals with a dial indicator.
4. Replace or recondition crankshaft if not within specifications.

INSTALLATION

1. Install crankshaft gear as shown in Figure 1B.

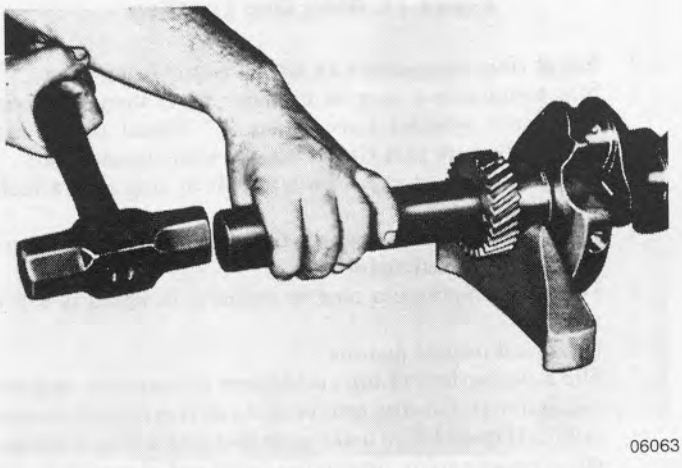


Figure 1B. Installing Crankshaft Gear

2. Install crankshaft as follows:
   a. Install rear main bearing oil seal in cylinder block and rear main bearing cap grooves. Install with lip of seal toward inside of engine.
   b. Lubricate lip of seal with engine oil. Keep oil off parting line surface.
   c. Install main bearings in cylinder block and main bearing caps, then lubricate bearing surface with engine oil.
   d. Install crankshaft, being careful not to damage bearing surfaces.
   e. Apply a thin coat of Perfect Seal to block mating surface and corresponding surface of cap only. Do not allow sealer on crankshaft or seal lip.
   f. Install main bearing caps with arrows pointing toward front of engine.
   g. Torque all except rear main bearing cap bolts to 10-12 lbs. ft. (14-16 N.m). Torque rear main bearing cap bolts to specifications, then tap end of crankshaft, first from rear then forward, with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing cap bolts to specifications.
   h. Measure crankshaft end play with a feeler gauge. Force crankshaft forward and measure clearance between front of rear main bearing and crankshaft thrust surface. (Figure 1C)
3. Install connecting rod and caps.
4. Install crankcase front cover.
5. Install oil pump and oil pan.

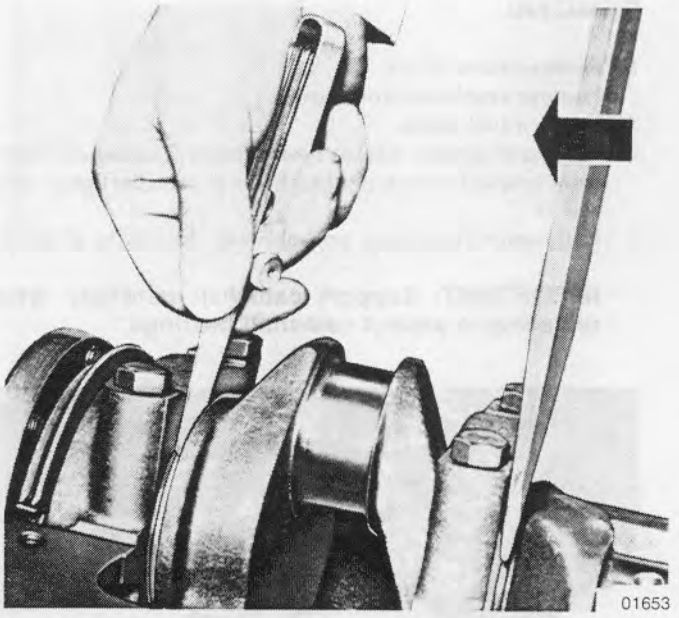


Figure 1C. Measuring Crankshaft End Play

6. Install crankshaft pulley or torsional damper.
7. Install starter motor.
8. Install flywheel, coupler and flywheel housing.
9. Install spark plugs and torque to specifications.

CAMSHAFT

MEASURING LOBE LIFT

NOTE: Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record the readings.

1. Remove valve mechanism.
2. Position indicator with ball socket adaptor (Tool J-8520) on push rod. (Figure 2)
3. Rotate torsional damper slowly in direction of rotation until lifter is on lowest position of cam lobe.
4. Set dial indicator on zero, then rotate damper slowly, or attach an auxiliary starter switch and "bump" engine over, until push rod is in fully raised position.
5. Compare total lift recorded from dial indicator with "Specifications".
6. Continue to rotate crankshaft until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism as outlined.

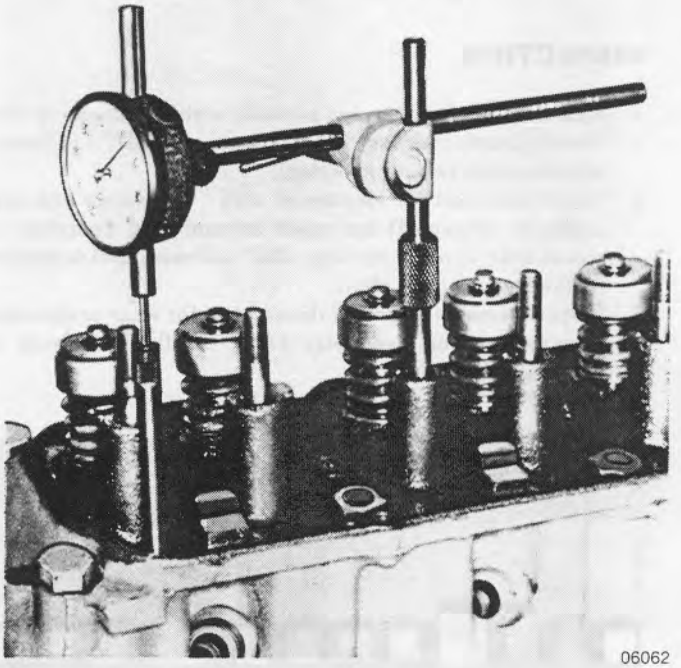


Figure 2. Measuring Camshaft Lobe Lift

REMOVAL

1. Remove valve lifters.
2. Remove crankcase front cover.
3. Remove fuel pump.
4. Align timing gear marks, then remove 2 camshaft thrust plate screws by working thru holes in camshaft gear. (Figure 3)
5. Pull camshaft and gear assembly out thru front of block.

IMPORTANT: Support camshaft carefully when removing to protect camshaft bearings.

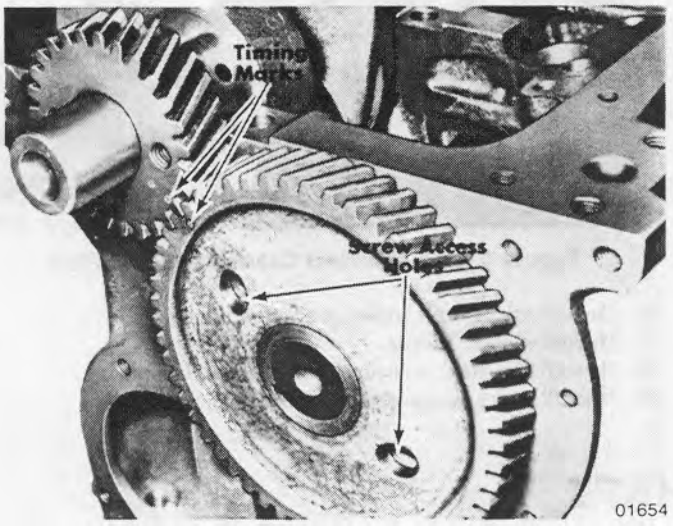


Figure 3. Timing Gear Marks

INSPECTION

1. Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001" (.025mm) out-of-round, replace camshaft.
2. Check camshaft for alignment with "V" blocks and dial indicator (Figure 4) for exact amount that camshaft is out-of-true. If out more than .002" (.05mm) dial indicator reading, replace camshaft.
3. Inspect camshaft gear and thrust plate for wear or damage. Measure camshaft end play [.001" to .005" (.03mm to .1mm)]. (Figure 5)

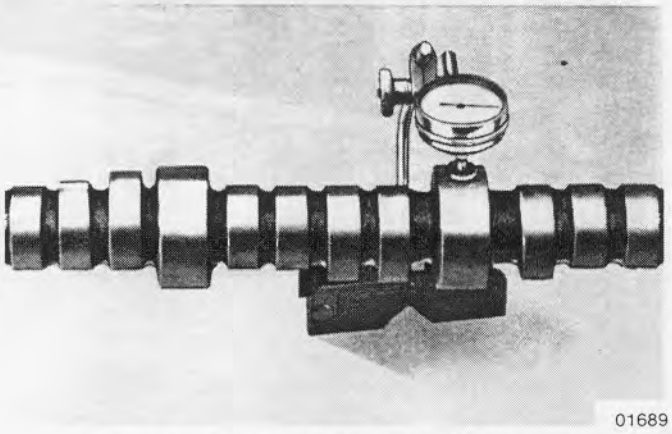


Figure 4. Checking Camshaft Alignment

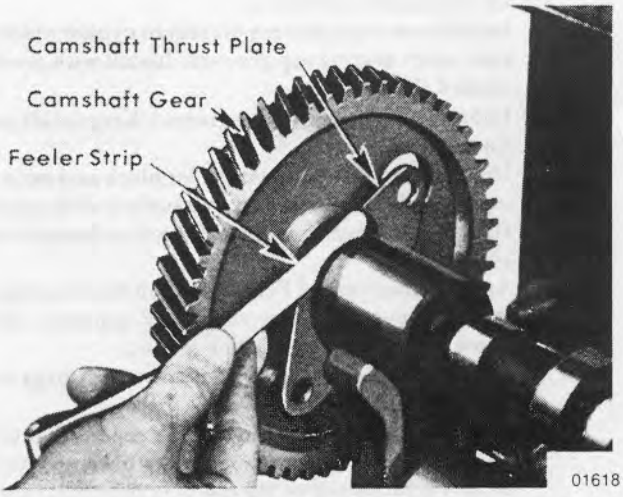


Figure 5. Measuring Camshaft End Play

CAMSHAFT GEAR REPLACEMENT

1. If inspection (preceding) indicated that camshaft, gear or thrust plate should be replaced, remove gear from camshaft.
2. Place camshaft thru gear remover, place end of remover on table of a press and press shaft out of gear. (Figure 6)

⚠CAUTION

Position thrust plate so that woodruff key in shaft does not damage plate when shaft is pressed out of gear. Also support hub of gear, or gear will be seriously damaged.

3. To assemble camshaft gear, thrust plate and gear spacer ring to camshaft, firmly support camshaft at back of front journal in arbor press.

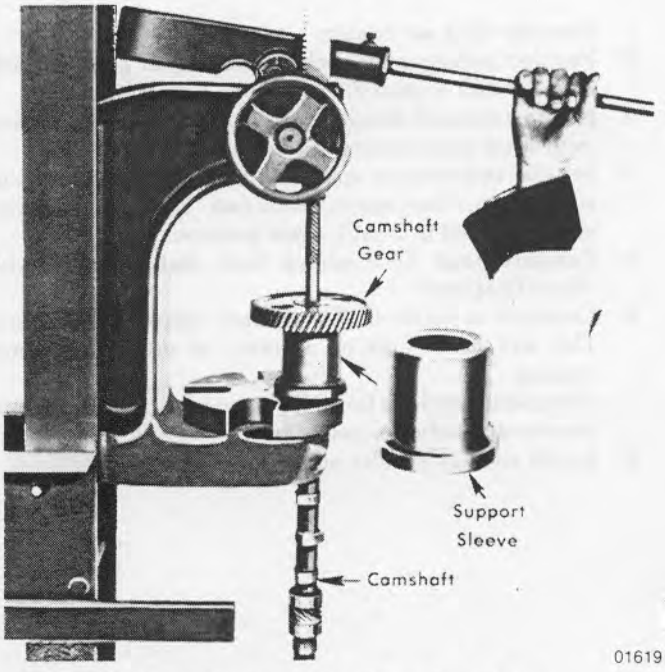


Figure 6. Removing Camshaft Gear

4. Place gear spacer ring and thrust plate over end of shaft, and install woodruff key in shaft keyway. Press shaft gear onto shaft until it bottoms against gear spacer ring. End clearance of thrust plate should be .001" to .005" (.03mm to .1mm). (Figure 5)

INSTALLATION

1. Install camshaft and gear assembly in engine block, being careful not to damage camshaft bearings or camshaft.

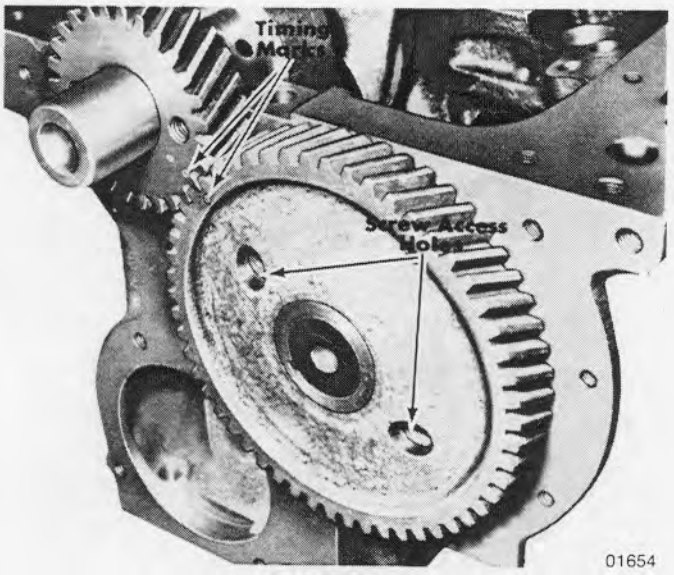


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Figure 7. Crankshaft Gear

2. Turn crankshaft and camshaft so that timing marks on gear teeth will line up. (Figure 7) Push camshaft thrust plate to block screws and torque to specifications.
3. Check camshaft and crankshaft gear run-out with a dial indicator. (Figure 8) Camshaft gear run-out should not exceed .004" (.1mm) and crankshaft gear run-out should not exceed .003" (.07mm).
4. If gear run-out is excessive, remove gear and clean burrs from shaft, or gear must be replaced.
5. Check backlash between timing gear teeth with a dial indicator. (Figure 9) Backlash should not be less than .004" (.1mm), nor more than .006" (.15mm).
6. Install fuel pump.
7. Install crankcase front cover.
8. Pour G.M. Engine Oil Supplement or light engine oil over camshaft lobes and install valve lifters.

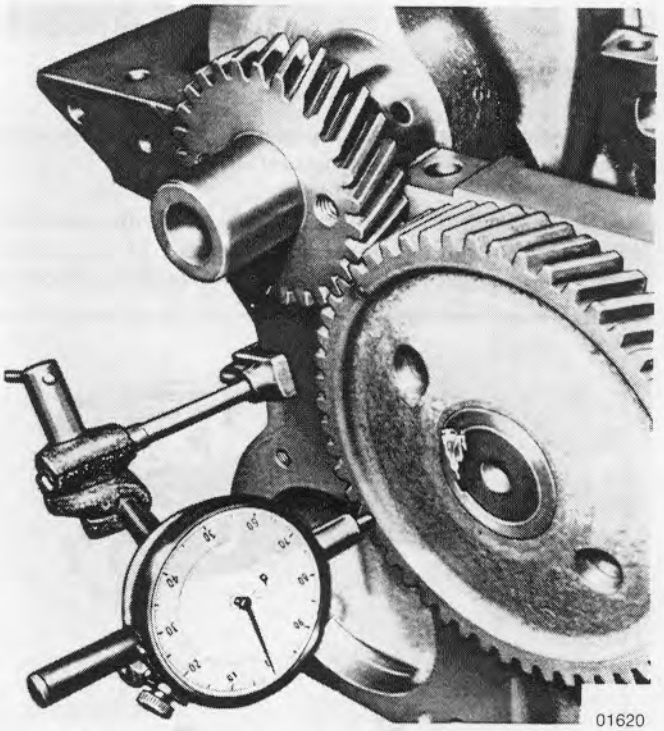
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Figure 8. Checking Timing Gear Run-Out

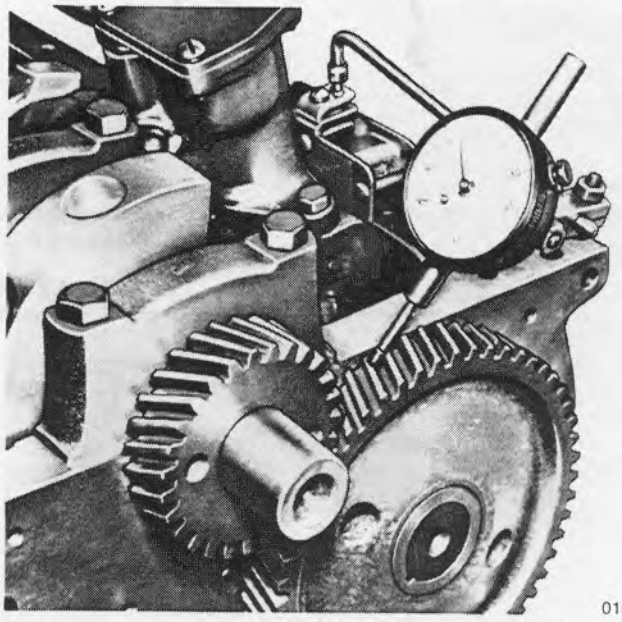
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Figure 9. Checking Timing Gear Backlash

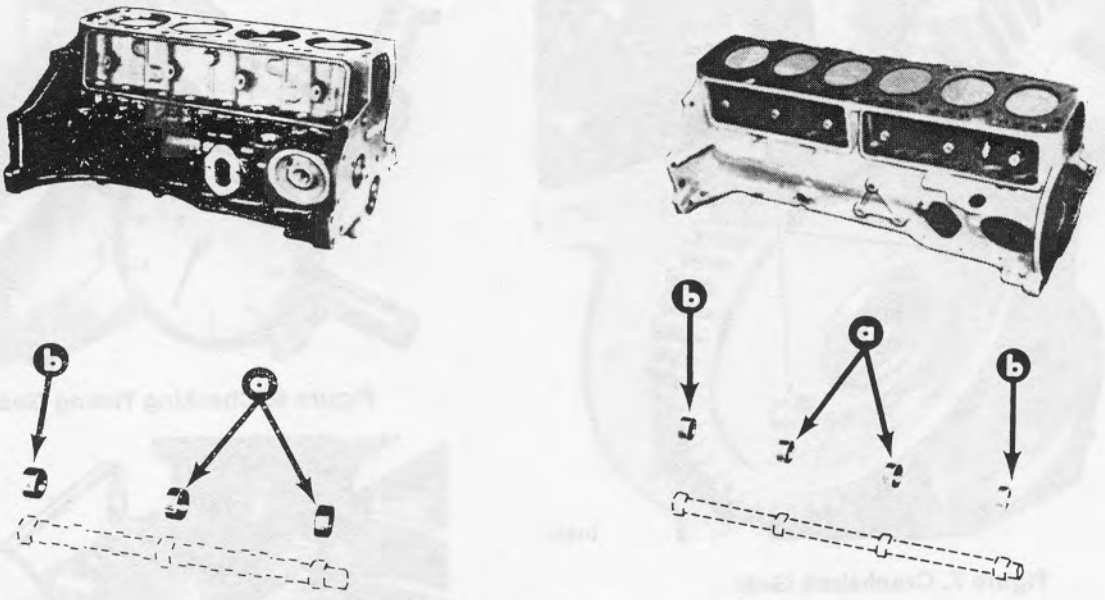
CAMSHAFT BEARINGS

REMOVAL

With camshaft removed, inspect bearings for evidence of wear or damage. Replace defective bearings.

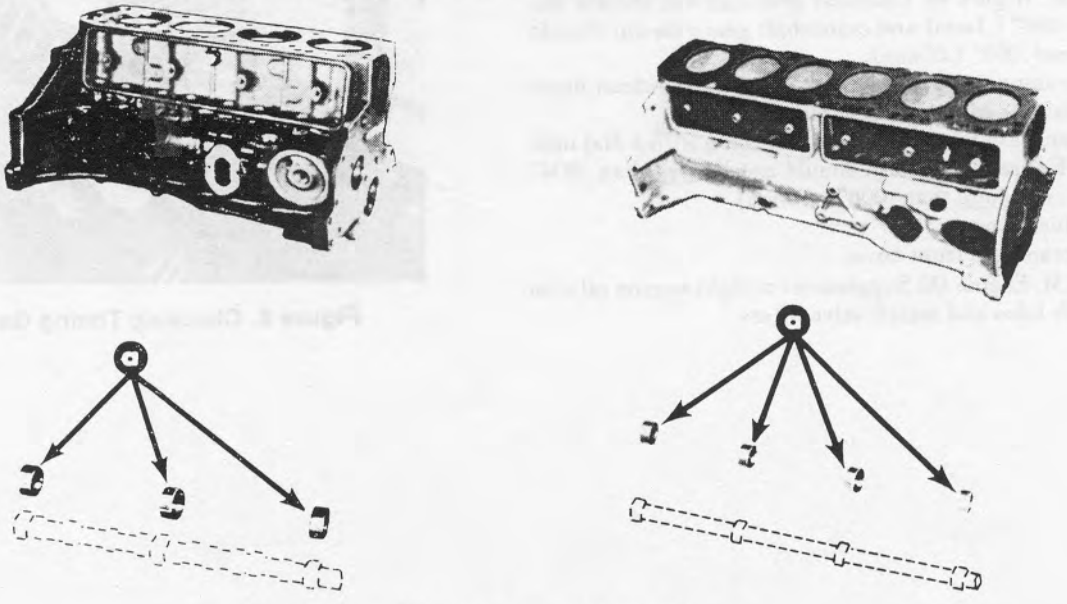
Replace camshaft bearings while engine is disassembled for overhaul or without complete disassembly of the engine. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so that rods will not hinder camshaft bearing replacement.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.



a - Bearing O.D. 1.999"-2.001" (50.77-50.83mm)
b - Bearing O.D. 2.009"-2.011" (51.03-51.08mm)

Use 23-85720 Bearing Set



a - Bearing O.D. 1.999"-2.001" (50.77-50.83mm)

Use 23-43293 Bearing Set

Figure 10. Camshaft Bearing O.D.

NOTE: This procedure is based on removal of bearings nearest center of engine first. Thus, a minimum number of turns are necessary to remove all bearings.

2. Using Tool Set J-6098-01, with nut and thrust washer installed to end of threads, position pilot in front camshaft bearing and install puller screw thru pilot.
3. Install remover and installer tool with shoulder toward bearing, making sure a sufficient amount of threads are engaged.
4. Using 2 wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw. (Figure 11)
5. Remove remaining bearings (except front and rear) in same manner. Position pilot in rear camshaft bearing to remove rear intermediate bearing.
6. Assemble remover and installer tool on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block. (Figure 12)

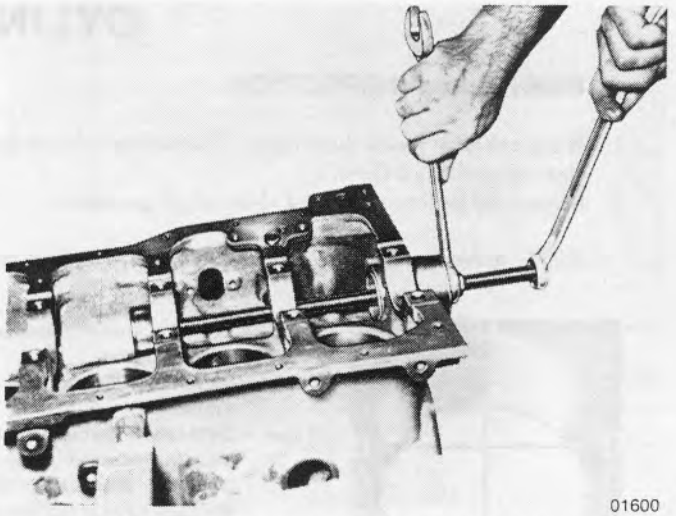


Figure 11. Pulling Bearing from Bore

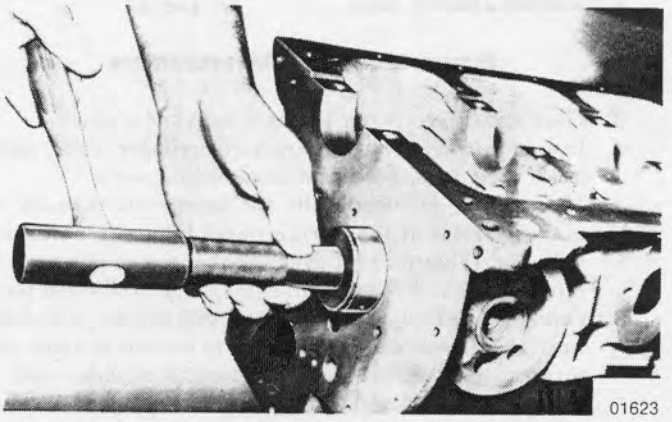


Figure 12. Removing and Installing Camshaft Bearings

INSTALLATION

Refer to Figure 10 for correct bearing set(s). Install front and rear camshaft bearings first. These bearings will act as guides for pilot and center remaining bearings being pulled into place.

1. Assemble remover and installer tool on driver handle and install front and rear camshaft bearings by driving toward center of cylinder block. (Figure 12)

⚠CAUTION

Oil holes in bearings must line up with oil holes in cylinder block. Oil hole is on top side of bearing shell and cannot be seen during installation, so first align bearing shell oil hole with oil hole in bore and mark opposite side of bearing and block at bore to easily position oil hole during installation.

IMPORTANT: Front bearing must be driven approximately ⅛" (3mm) behind front of cylinder block to uncover oil hole to timing gear oil nozzle.

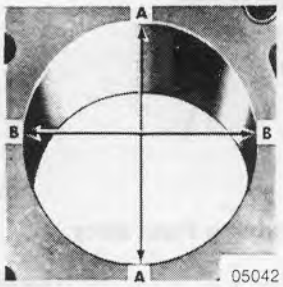
2. Using Tool Set J-6098-01, with nut and thrust washer installed to end of threads, position pilot in front camshaft bearing and install puller screw thru pilot.
3. Index camshaft bearing in bore, then install remover and installer tool on puller screw with shoulder toward bearings.
4. Using 2 wrenches, hold puller screw while turning nut. After bearing has been pulled into bore, remove tool from puller screw and check alignment of oil hole in camshaft bearing.
5. Install remaining bearings in same manner. Position pilot in rear camshaft bearing to install rear intermediate bearing.
6. Install a new camshaft rear plug flush to 1/32" (.8mm) deep and parallel with rear surface of cylinder block. Use Perfect Seal on plug.

CYLINDER BLOCK

CLEANING and INSPECTION

1. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
2. Remove oil gallery plugs and clean all oil passages.

NOTE: Remove plugs with a sharp punch or drill and pry out.



"A" = At Right Angle to Centerline of Engine
"B" = Parallel to Centerline of Engine
Taper = Difference between "A" Measurement at Top of Cylinder Bore and "A" Measurement at Bottom of Cylinder Bore
Out-of-Round = Difference between "A" and "B"

Figure 1. Cylinder Measurement

3. Clean and inspect water passages in cylinder block.
4. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
5. Measure the cylinder walls for taper, out-of-round or excessive ridge at top of ring travel (Figure 1) with dial indicator. (Figure 2) Set gauge so that thrust pin must be forced in about ¼" (6mm) to enter gauge in cylinder bore. Center gauge in cylinder and turn dial to "O". Carefully work gauge up-and-down cylinder to determine taper and turn gauge to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, honing and/or boring are necessary.

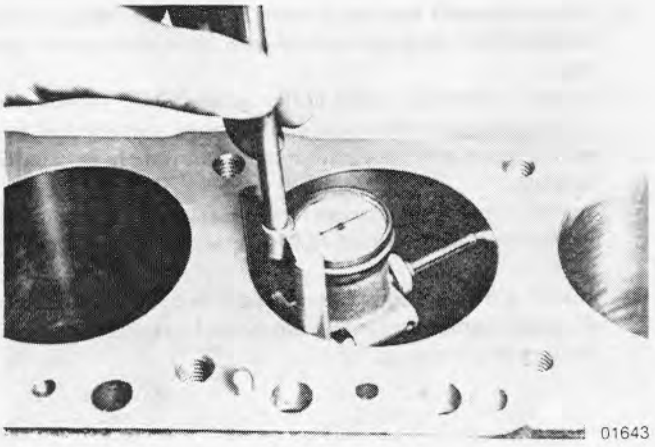


Figure 2. Measuring Cylinder Bore

REPAIRS

Cylinder Conditioning

Condition of engine at time of repair is important. If inspection indicates that cylinder block is acceptable, except for out-of-round or tapered cylinders, condition the block by honing or boring.

If cylinders have less than .005" (.1mm) taper or wear, condition them with a hone and fit with high limit, standard size piston. A cylinder bore of less than .005" wear or taper may not clean up entirely when fitted to a high limit piston. To clean up bore entirely, in such a case, rebore for an oversize piston. If more than .005" taper or wear, bore and hone to smallest oversize that permits complete resurfacing of all cylinders.

When pistons are fitted (honing no longer necessary), clean (scrub) cylinder bores with detergent and hot water. After cleaning, swab cylinder bores several times with light engine oil with clean cloth, then wipe with clean, dry cloth.

Cylinder Boring

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This will guard against a tilted boring bar and assures that rebored cylinder wall is at right angles to crankshaft.
2. Measure piston, to be fitted, with a micrometer at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone cylinder to specifications and as outlined under "Cylinder Honing" and "Piston Selection".
3. Carefully follow instructions furnished by manufacturer of equipment being used.

Cylinder Honing

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish honing a cylinder bore to fit a piston, move hone up-and-down to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 30° to cylinder bore. Finish marks should be clean but not sharp and free from imbedded particles and torn or folded metal.

⚠CAUTION

Handle pistons with care and do not attempt to force them thru cylinder until cylinder has been honed to correct size, as this type piston can be distorted thru careless handling.

4. Permanently mark piston for cylinder to which it has been fitted and proceed to hone cylinders and fit remaining pistons.
5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. Be absolutely certain that no abrasive material is allowed to remain in cylinder bores, or it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by contaminated oil. Swab bores several times with light engine oil with a clean cloth, then wipe with a clean, dry cloth. DO NOT clean cylinder with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION

1. Check USED piston to cylinder bore clearance as follows:
   a. Measure "Cylinder Boer Diameter" with a telescope gauge [2½" (64mm) from top of cylinder bore].
   b. Measure "Piston Diameter" (at skirt across centerline of piston pin).
   c. Subtract piston diameter from cylinder bore diameter to determine "Piston to Bore Clearance".
   d. Determine if piston to bore clearance is in acceptable range.
2. If piston to bore clearance is not acceptable, check Parts Manual for oversize pistons.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance.
4. Mark piston to identify cylinder for which it was fitted.

DISTRIBUTOR LOWER BUSHING

INSPECTION and REPLACEMENT

Distributor lower bearing is a bronze bushing pressed into lower side of engine block. Its upper inside diameter pilots distributor shaft, and outside diameter (extending below block) pilots oil pump.

Some engines have a thrust washer at upper end of bushing bore. Thrust washer, where used, may be replaced at same time bushing is replaced.

Lower bushing ordinarily will require only a clearance or wear check during engine overhaul. When distributor shaft-to-bushing clearance exceeds .035" (.08mm), replace bushing, as follows, with oil pump and distributor removed:

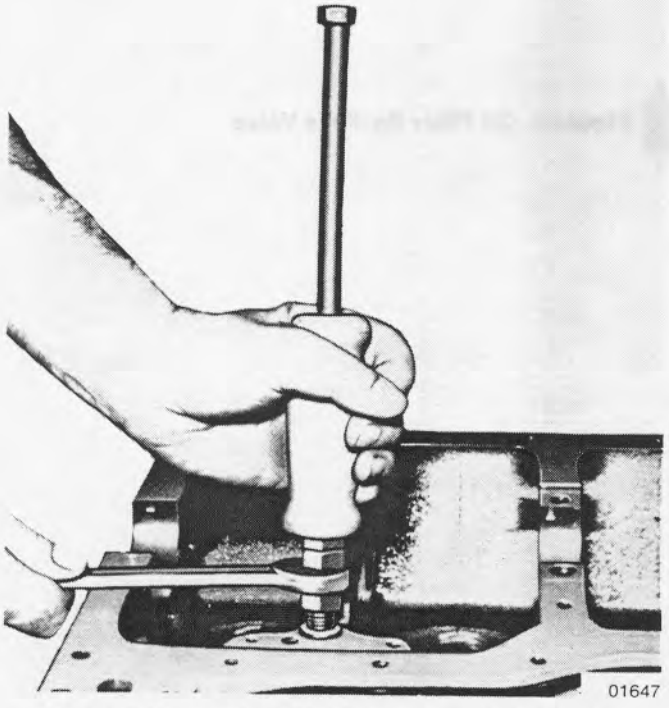


Figure 3. Removing Distributor Lower Bearing

IMPORTANT: Later distributors use a bushing in distributor housing. Measuring clearance between cylinder block bushing and distributor shaft is not needed, since distributor shaft is undercut.

1. Install Tool J-9534-01 into bushing and remove bushing with a slide hammer. (Figure 3)
2. Clean bushing bore in block and check for burrs or damage.

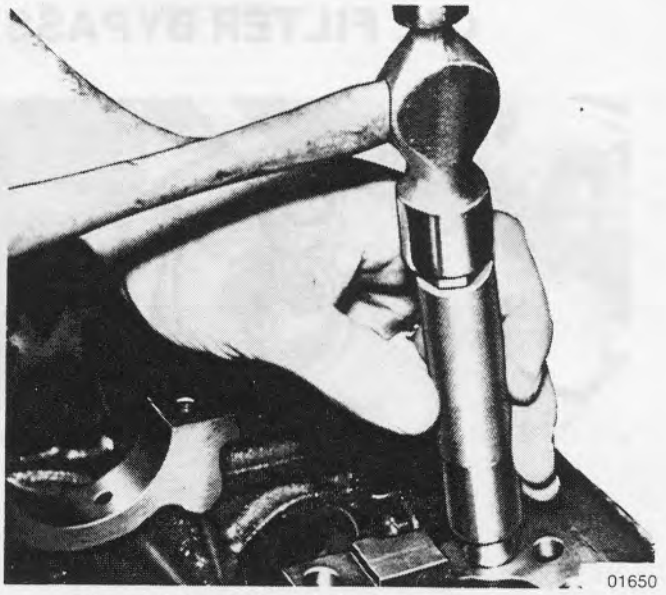
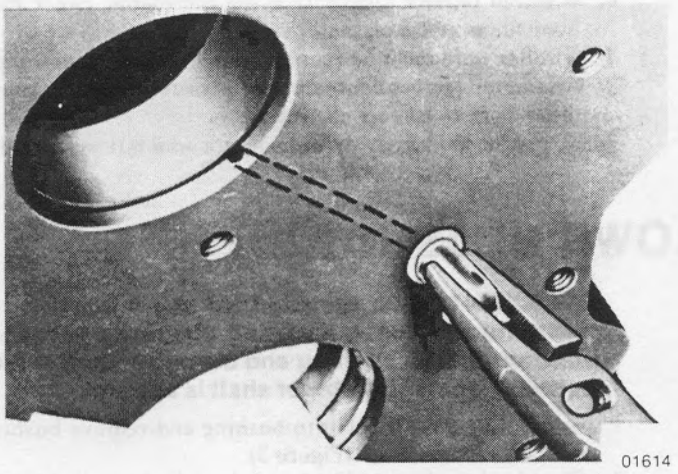


Figure 4. Install Distributor Lower Bearing

3. Use tool with driver-bolt in driver handle to install driver into new bushing from large inside diameter.
4. Position bushing and driver to block and drive bushing in position (Figure 4), which is determined by tool bottoming against block.
5. Remove tool from bushing. It is possible that bushing with minimum inside diameter will collapse enough during installation to slightly seize installer arbor. If this happens, remove installer tool with slide hammer in driver bolt hole of driver handle.

NOTE: This will not damage bushing, and tool is designed for this purpose, should it occur.

OIL NOZZLE REPLACEMENT

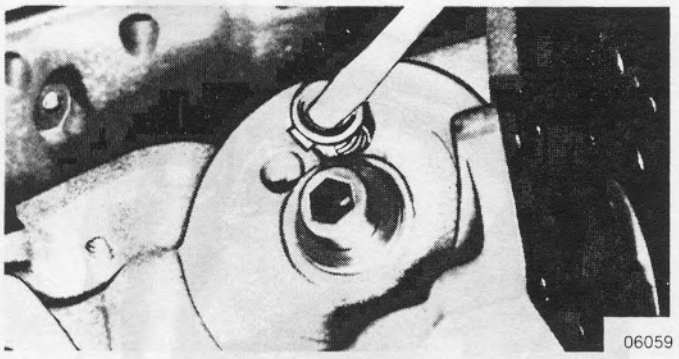


1. Remove nozzle with pliers. (Figure 5)
2. Drive new nozzle in place (oil hole in vertical position) with a suitable light plastic or rubber hammer.

IMPORTANT: Later model engines DO NOT have an oil nozzle. A plug is used to seal this hole.

Figure 5. Oil Nozzle Replacement

OIL FILTER BYPASS VALVE and REPLACEMENT

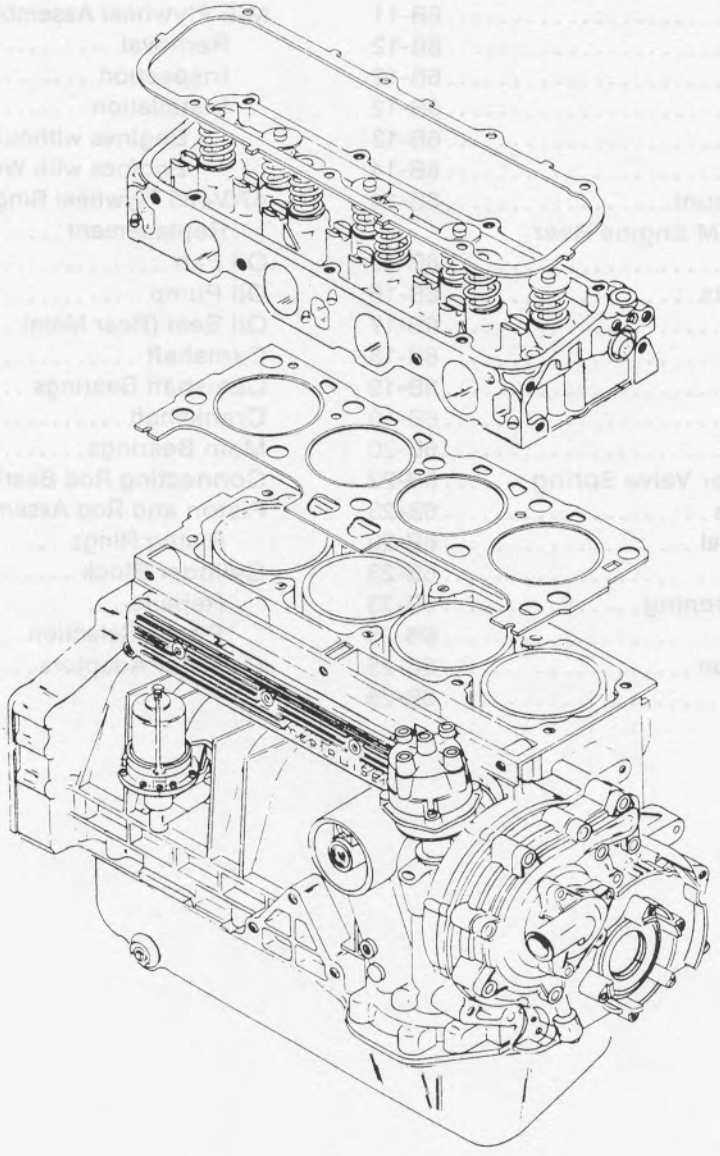


With oil filter removed, check spring and fiber valve for operation. Inspect for a cracked or broken valve. If replacement is necessary, pry valve out with screwdriver. Install and seat a new valve by tapping in place with a 9/16 thin-wall deep socket. (Figure 6)

Figure 6. Oil Filter By-Pass Valve

SECTION 6 - ENGINE

PART B - MERCURY MARINE 4 CYLINDER ENGINE



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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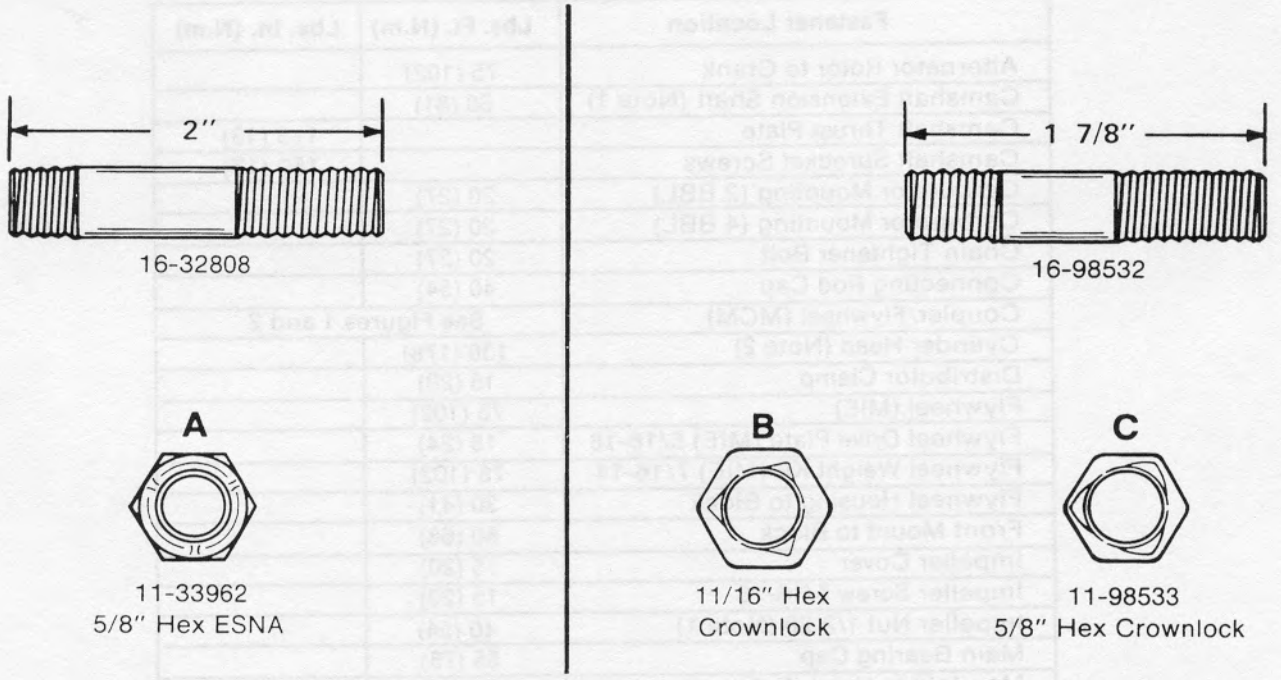
TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Rotor to Crank	75 (102)	
Camshaft Extension Shaft (Note 1)	60 (81)	
Camshaft Thrust Plate		115 (13)
Camshaft Sprocket Screws		150 (17)
Carburetor Mounting (2 BBL)	20 (27)	
Carburetor Mounting (4 BBL)	20 (27)	
Chain Tightener Bolt	20 (27)	
Connecting Rod Cap	40 (54)	
Coupler/Flywheel (MCM)	See Figures 1 and 2	
Cylinder Head (Note 2)	130 (176)	
Distributor Clamp	15 (20)	
Flywheel (MIE)	75 (102)	
Flywheel Drive Plate (MIE) 5/16-18	18 (24)	
Flywheel Weight Kit (MIE) 7/16-14	75 (102)	
Flywheel Housing to Block	30 (41)	
Front Mount to Block	50 (68)	
Impeller Cover	15 (20)	
Impeller Screw 5/16-18	15 (20)	
Impeller Nut 1/2-20 (Note 1)	40 (54)	
Main Bearing Cap	55 (75)	
Manifold to Head (Exhaust)	25 (34)	
Manifold to Head (Intake)	25 (34)	
Oil Pan		130 (15)
Oil Pan Drain Plug	20 (27)	
Oil Pump Cover		120 (14)
Oil Pump to Block	25 (34)	
Oil Pump Pickup	20 (27)	
Oil Tube to Block	20 (27)	
Rear Mount to Transmission (MIE)	50 (68)	
Rocker Arm Cover		90 (10)
Rocker Arm Bolt (Note 3)	20 (27)	
Side Cover	15 (20)	
Spark Plug (14mm)	15 (20)	
Starter Motor	60 (81)	
Stator to Front Cover		45 (5)
Timing Chain Cover	15 (20)	
Transmission to Flywheel Housing (MIE)	50 (68)	
Water Pump Cover	15 (20)	

NOTES: 1. *Left Hand (L.H.) Thread*
2. *Torque with Valves Closed and in 3 Steps. Retorque After First Start Up.*
3. *Torque with Valves Closed.*

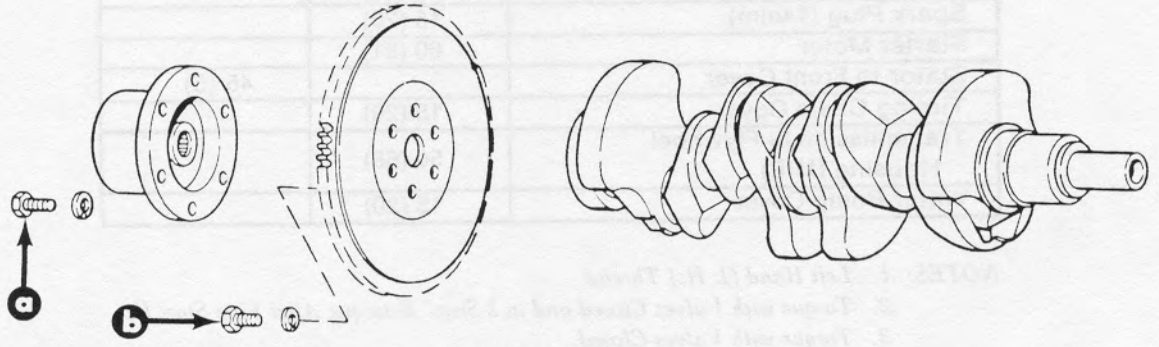
IMPORTANT: DO NOT intermix stud/nut combinations.



A - 45 Lbs. Ft. (61 N.m)
B - 35 Lbs. Ft. (42 N.m)
C - 40 Lbs. Ft. (54 N.m)
D - See Figure 3. For Coupler Wrench Modification

269-H

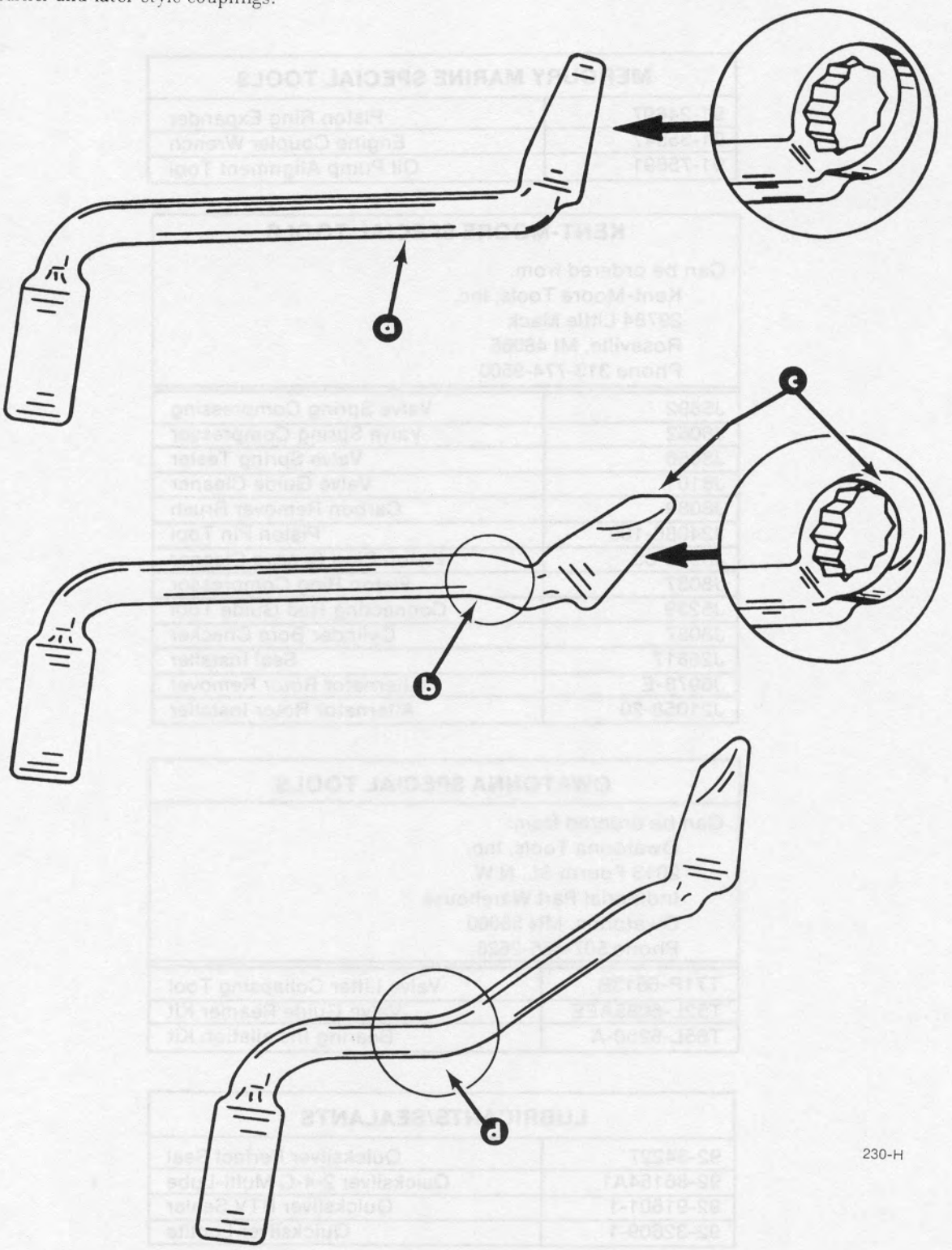
Figure 1. MCM 470 (Serial No. 6218036 and Below), MCM 485 Engine Coupler/Flywheel



a - 25-30 Lbs. Ft. (34-41 N.m)
b - 75 Lbs. Ft. (120 N.m)

Figure 2. MCM 470R (Serial No. 6218037 and Above), MCM 488R Engine Coupler/Flywheel

Engine Coupler Wrench, 91-35547, may not work on the later couplers. Modify wrench as shown in Figure 3, so it will work on both earlier and later style couplings.



a - Original 91-35547 Wrench
b - Heat and Bend as Shown
c - Grind Area Shown Slightly
d - Heat and Bend as Shown (This is what wrench should look like when it's done)

Figure 3. Modifying Engine Coupler Wrench

TOOLS/LUBRICANTS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-24697	Piston Ring Expander
91-35547	Engine Coupler Wrench
91-75691	Oil Pump Alignment Tool

KENT-MOORE SPECIAL TOOLS	
Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone 313-774-9500	
J5892	Valve Spring Compressing
J8062	Valve Spring Compressor
J8056	Valve Spring Tester
J8101	Valve Guide Cleaner
J8089	Carbon Remover Brush
J24086-100	Piston Pin Tool
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J5239	Connecting Rod Guide Tool
J8087	Cylinder Bore Checker
J26817	Seal Installer
J6978-E	Alternator Rotor Remover
J21058-20	Alternator Rotor Installer

OWATONNA SPECIAL TOOLS	
Can be ordered from: Owatonna Tools, Inc. 2013 Fourth St., N.W. Industrial Part Warehouse Owatonna, MN 55060 Phone 507-455-2626	
T71P-6513B	Valve Lifter Collapsing Tool
T52L-6085AEE	Valve Guide Reamer Kit
T65L-6250-A	Bearing Installation Kit

LUBRICANTS/SEALANTS	
92-34227	Quicksilver Perfect Seal
92-86154A1	Quicksilver 2-4-C Multi-Lube
92-91601-1	Quicksilver RTV Sealer
92-32609-1	Quicksilver Loctite

ENGINE SPECIFICATIONS

UNIT OF MEASUREMENT in. (mm)

MODEL	470	485	488
CU. IN. DISPLACEMENT	224 (3.7 litres)		

CYLINDER BORE:

Diameter			4.3602-4.3609 (110.749-110.767)
Out of Round		Production	.0005 (.0127) Max.
		Service	.0015 (.0381) Max.
Taper	Production	Thrust Side	.0005 (.0127) Max.
		Relief Side	.0005 (.0127) Max.
	Service		.003 (.076) Max.

CYLINDER BLOCK:

Deck Height (Note 1)	Production	10.255-10.265 (260.477-260.731)
	Service	10.240 (260.096) Min.
Main Bearing Bore Diameter	Production	2.9417-2.9425 (74.7191-74.7395)
	Service	2.9435 (74.7649) Max.
Hydraulic Lifter Bore Diameter	Production	.875-.876 (22.225-22.250)
	Service	.878 (22.301) Max.
Camshaft Bore Diameter		2.1258-2.1268 (53.995-54.021)

NOTE 1: Measured from center of main bearing bore to top of cylinder block.

PISTON: CLEARANCE

Production	See Page 6B-50
Service	See Page 6B-50

PISTON RING: COMPRESSION

Groove Clearance	Production	Top	.0025-.004 (.07-.1)
		2nd	.0025-.004 (.07-.1)
	Service	Top	.0025-.004 (.07-.1)
		2nd	.0025-.004 (.07-.1)
Gap	Production	Top	.010-.020 (.25-.5)
		2nd	.010-.020 (.25-.5)
	Service	Top	.010-.020 (.25-.5)
		2nd	.010-.020 (.25-.5)

PISTON RING: OIL

Groove Clearance	Production	.0011-.0065 (.03-.15)
	Service	.0011-.0065 (.03-.15)
Gap	Production	.010-.025 (.25-.6)
	Service	.010-.025 (.25-.6)

PISTON PIN:

Diameter		1.0399-1.0402 (26.413-26.421)
Clearance	Production	.0004-.0006 (.0102-.0152)
	Service	.0004-.0006 (.0102-.0152)
Fit in Rod		.0006-.0016 (.0152-.0406) Interference

(Continued on Next Page)

MODEL	470	485	488

CRANKSHAFT:

Diameter			2.7472-2.7482 (69.779-69.804)
Main Journal	Taper	Production	.0002 (.0051) Max.
		Service	.0005 (.0127) Max.
	Out of Round	Production	.0002 (.0051) Max.
		Service	.0005 (.0127) Max.
Main Brg. Clearance		Production	.0009-.0031 (.0228-.0787)
		Service	.001-.003 (.03-.07)
Rear Seal Area Diameter		Production	3.748-3.752 (95.1992-95.3008)
		Service	3.745 (95.123) Min.
Timing Sprocket (Note 1)		Production	1.380-1.381 (35.052-35.077)
		Service	1.379 (35.026) Min.
Balance of Crankshaft (Note 2)		Production	.50 oz. in.
Crankshaft End Play			.006-.010 (.15-.25)
Crankpin	Diameter		2.4979-2.4989 (63.447-63.472)
	Taper	Production	.0002 (.051) Max.
		Service	.0005 (.0127) Max.
	Out of Round	Production	.0002 (.051) Max.
		Service	.0005 (.0127) Max.
Rod Brg. Clearance		Production	.0009-.0031 (.0228-.0787)
		Service	.001-.003 (.03-.07)
Rod Side Clearance			.005-.012 (.15-.3)

NOTE 1: Because crankshaft has taper, measurement must be taken at rear half of sprocket area on crankshaft.
NOTE 2: Balanced without connecting rods.

ALTERNATOR ROTOR:

Front Oil Seal Diameter	Production	1.873-1.877 (47.5742-47.6758)
	Service	1.871 (47.5234) Min.

CRANKSHAFT TIMING SPROCKET:

Inside Diameter	Production	1.381-1.382 (35.0774-35.1028)

CAMSHAFT:

End Play		.002-.005 (.06-.1)		
Lobe Lift (Max.)	Intake	.278 (7.061)	(Note 1)	.286 (7.2644)
	Exhaust	.290 (7.366)	(Note 1)	.298 (7.5692)
Lobe Wear Limit		.009 (.2286) Max.		
Journal Diameter		2.1242-2.1248 (53.955-53.970)		
Clearance		.001-.0026 (.0254-.0660)		
Camshaft Runout		.001 (.0254) Max.		
Timing Chain Deflection		1 (25)		

CYLINDER HEAD:

Gasket Surface Flatness	.005 (.1) Max.

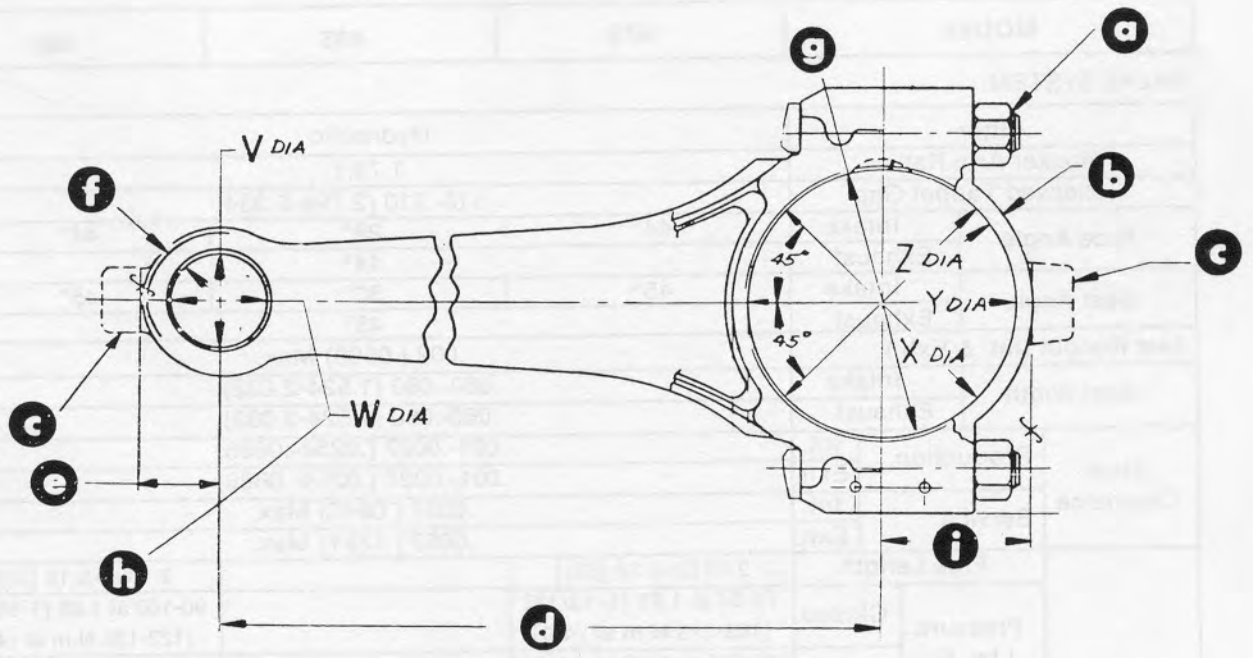
NOTE 1: 466-7553 Camshaft with Green Paint I.D. - Intake: .300 (7.620), Exhaust: .308 (7.823)
466-8330 Camshaft with Orange Paint I.D. - Intake: .286 (7.2644), Exhaust: .310 (7.8740)

MODEL	470	485	488

VALVE SYSTEM:

Lifter			Hydraulic		
Rocker Arm Ratio			1.73:1		
Collapsed Tappet Gap			.110-.210 (2.794-5.334)		
Face Angle	Intake		44°	29°	44°
	Exhaust		44°		
Seat Angle	Intake		45°	30°	45°
	Exhaust		45°		
Seat Runout (Int. & Exh.)			.002 (.0508) Max.		
Seat Width	Intake		.060-.080 (1.524-2.032)		
	Exhaust		.060-.080 (1.524-2.032)		
Stem Clearance	Production	Int.	.001-.0027 (.0254-.0686)		
		Exh.	.001-.0027 (.0254-.0686)		
	Service	Int.	.0037 (.0940) Max.		
		Exh.	.0052 (.1321) Max.		
Springs (Note 1)	Free Length		2.03 [2-1/32 (52)]		2.18 [2-3/16 (55)]
	Pressure Lbs. Ft.	Closed	76-84 at 1.81 [1-13/16] [103-113 N.m at (46)]		90-100 at 1.86 [1-55/64] [122-136 N.m at (47)]
		Open	240-265 at 1.33 [1-21/64] [325-359 N.m at (34)]		255-275 at 1.36 [1-23/64] [346-372 N.m at (35)]
	Installed Height ± 1/32" (.8mm)	Intake	1.81 [1-13/16 (46)]		1.86 [1-55/64 (47)]
		Exhaust	1.81 [1-13/16 (46)]		1.86 [1-55/64 (47)]
	Damper		None		External
Springs (Blue Stripe) (Note 1)	Free Length			2.28 [2-9/32 (60)]	
	Pressure Lbs. Ft.	Closed		82-94 at 1.90 [1-29/32] [111-127 N.m at (48)]	
		Open		214-238 at 1.30 [1-19/64] [290-322 N.m at (33)]	
	Installed Height ± 1/32" (.8mm)	Intake		1.90 [1-29/32 (48)]	
		Exhaust		1.90 [1-29/32 (48)]	
	Damper			Internal Coil	
Springs (Red Stripe) (Note 1)	Free Length			2.135 [2-9/64 (54)]	
	Pressure Lbs. Ft.	Closed		120-140 at 1.795 [1-51/64] [163-189 N.m at (46)]	
		Open		324-364 at 1.275 [1-9/32] [439-493 N.m at (32)]	
	Installed Height ± 1/32" (.8mm)	Intake		1.795 [1-51/64 (46)]	
		Exhaust		1.795 [1-51/64 (46)]	
	Damper			Internal Coil	

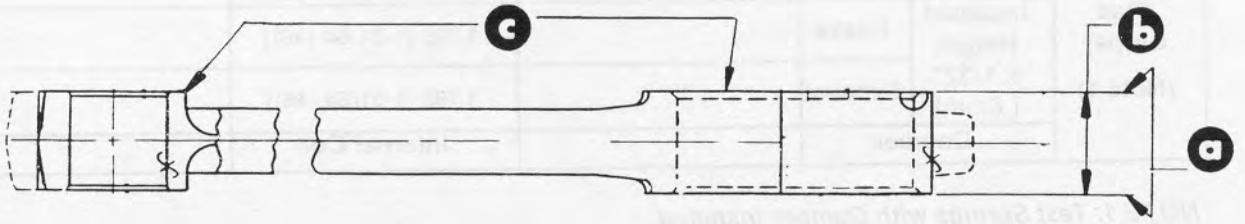
NOTE 1: Test Springs with Damper Installed



a - Torque to 40-45 Lbs. Ft. (54-61 N.m)
b - .155" (3.937mm) Min. Both Sides
c - Remove Metal From This Boss To Maintain Weight
d - 6.6035"-6.6065" (167.7289-167.8051mm)
e - .700" (17.780mm) Min.
f - .100" (2.540mm) Min. Both Sides
g - Production: 2.6522"-2.6530" (67.3658-67.3862); [Service: 2.6522"-2.6540" (67.3658-67.5116mm)] - Minor Diameter In Plane of Web In As Machined Condition. Measure at X-Y or Z. Major Diameter May Exceed Limits By Amount Following. Diameter Measurements Not to Vary In Excess of Production: .003" (.0762mm) [Service: .005" (.127mm)] Between "X" and "Y" (Octant Angle) or Between "Y" and "Z" (Octant Angle) or .0004" (.01016mm) Between "X" and "Z" (Quadrant Angle including Above Angles) Diametral Deviation (Barrel Shape - Hour Glass or Taper) When Measured In Plane Thru "Y" Containing The Axis Not to Exceed .0006" (.01524mm) Per Inch (25mm) Between Any Two Measuring Points and .0004" (.01016mm) Per Inch In Length of Journal
h - Diameter at "W" - Production: 1.0386"-1.0393" (26.38044-26.39822mm); [Service: 1.0386"-1.0395" (26.38044-26.40330 mm)] Piston Pin Hole Size To Be Measured In Plane of Web. Out of Round When Measured In Plane of Web - Diametral Dimension "V" To Be .0001" (.00254mm) Greater To .0004" (.01016mm) Smaller Than Diametral Dimension "W". Diametral Deviation (Barrel Shape - Hour Glass or Taper) When Measured In Plane Thru "W" Containing The Axis Must Not Exceed .0015" (.0381mm) Per Inch (25mm) and Not To Exceed .001" (.0254 mm) Total
i - 1.550" (39.37mm)

FINISHED WEIGHT OF ASSEMBLED ROD	
COMPLETE ROD	779-791 GRAMS
PISTON PIN END	204-210 GRAMS
CRANKSHAFT END	575-581 GRAMS

Figure 1. Connecting Rod



a - Runout of These Surfaces Must Be Within .0025" (.0635mm) Total Indicator Runout In Relation To Crankpin Bore
b - .9985"-1.0015" (25.3619-25.4381mm)
c - These Surfaces Must Be In A True Plane Within .010" (.254mm) Total Indicator Runout

Figure 2. Connecting Rod

GENERAL

Some repairs, that are listed in this section, must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

Lubricate all moving parts (during reassembly) with engine oil. Apply Perfect Seal on threads of and under head of cylinder head bolts and on threads of all cylinder block external bolts, screws and studs.

Cubic inch displacement of each MerCruiser model is listed below.

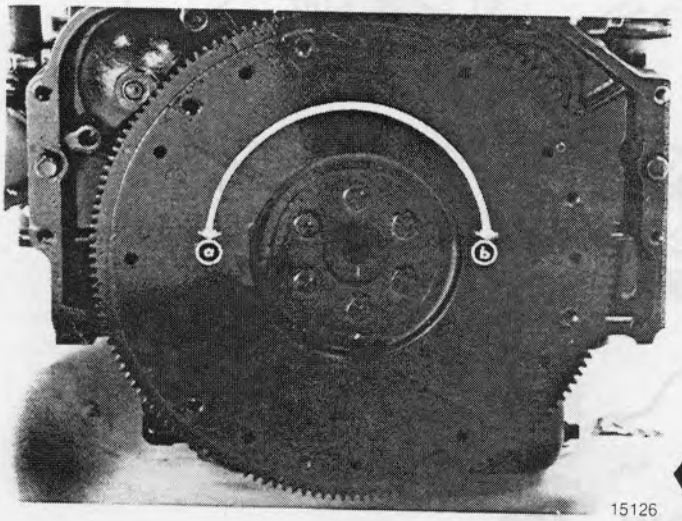
Model	No. of Cylinders	Cu. In. Displacement
MIE 470	4	224 (3.7 ltr.)
MCM 470	4	224 (3.7 ltr.)
MCM 485	4	224 (3.7 ltr.)
MCM 488	4	224 (3.7 ltr.)

ENGINE ROTATION

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

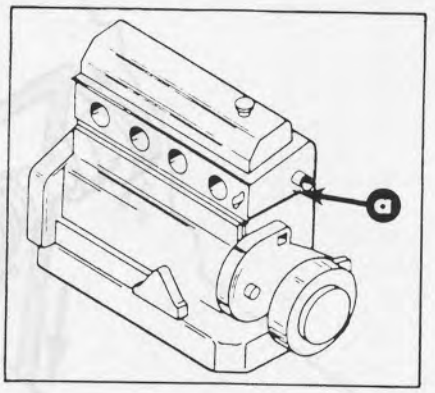
When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



a - Left Hand Rotation (CCW) - All Stern Drive (MCM) Engines, MIE Inboard L.H. (Standard) Rotation
b - Right Hand Rotation (CW) - MIE Inboard R.H. (Opposite) Rotation

ENGINE IDENTIFICATION

If the engine serial number and/or model decals are missing, the following will help in determining what model it is. Look for stamped code number in cylinder head. Also look at valve spring for color code.



a - "Stamped" Number

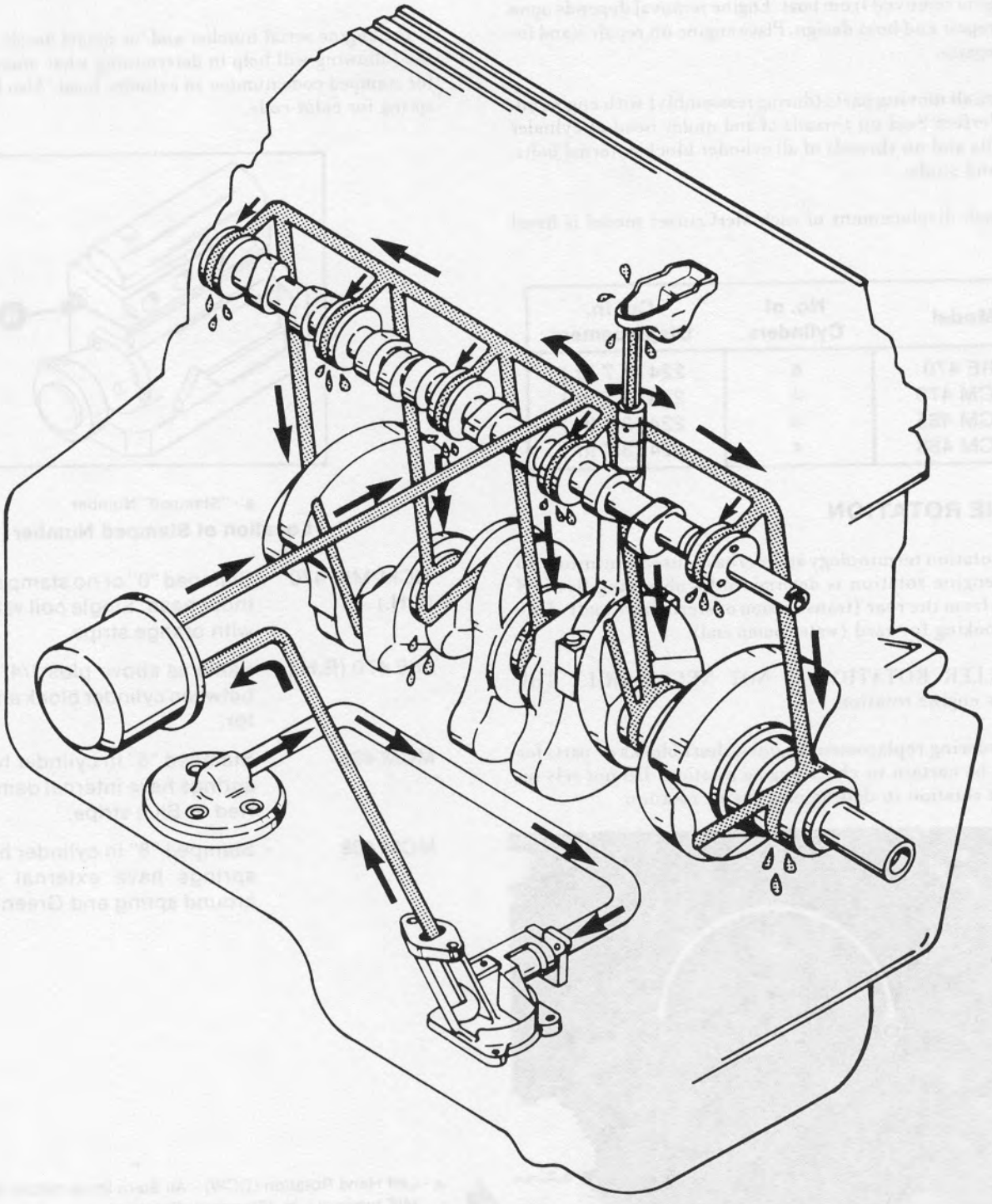
Location of Stamped Number

MCM/MIE 470 (L.H.) - Stamped "0" or no stamp at all in cylinder head. Single coil valve springs with orange stripe.

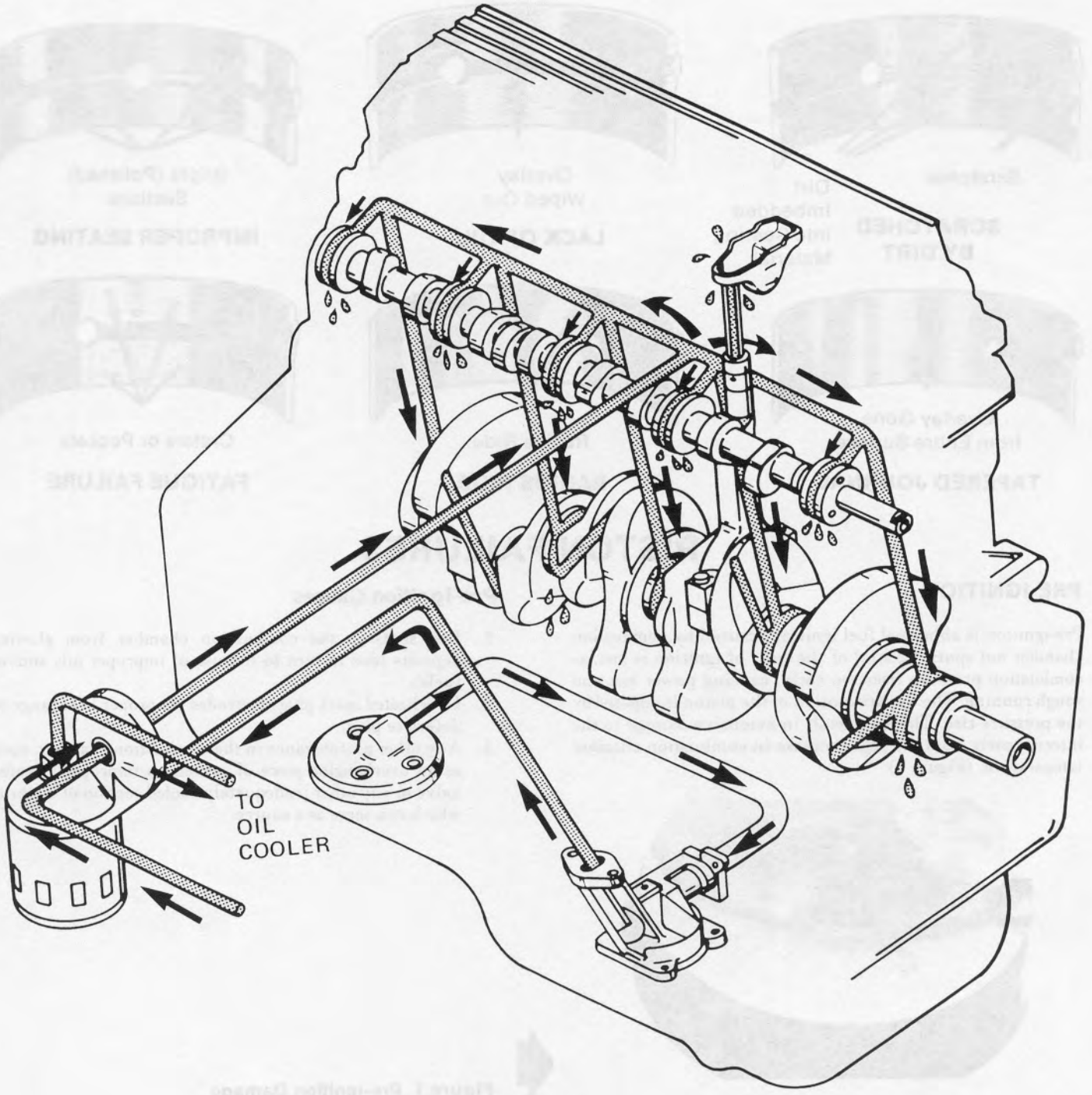
MIE 470 (R.H.) - Same as above plus 1/4" thick ring between cylinder block and distributor.

MCM 485 - Stamped "5" in cylinder head. Valve springs have internal dampener and Red or Blue stripe.

MCM 488 - Stamped "8" in cylinder head. Valve springs have external dampener around spring and Green stripe.

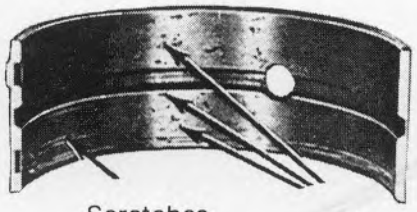


OIL FLOW - 470



OIL FLOW - 485/488

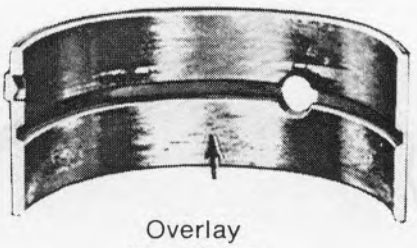
BEARING FAILURES



Scratches

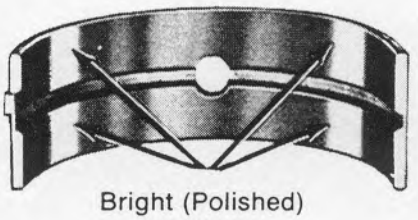
Dirt Imbedded into Bearing Material

SCRATCHED BY DIRT



Overlay Wiped Out

LACK OF OIL

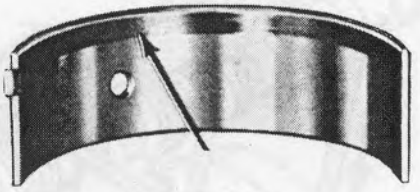


Bright (Polished) Sections

IMPROPER SEATING

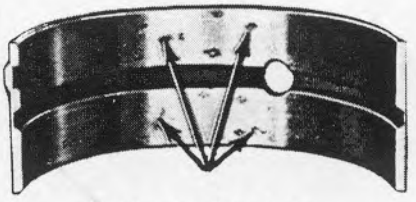
Overlay Gone from Entire Surface

TAPERED JOURNAL



Radius Ride

RADIUS RIDE



Craters or Pockets

FATIGUE FAILURE

PISTON FAILURES

PRE-IGNITION

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion of the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature. (Figure 1)

Pre-Ignition Causes

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

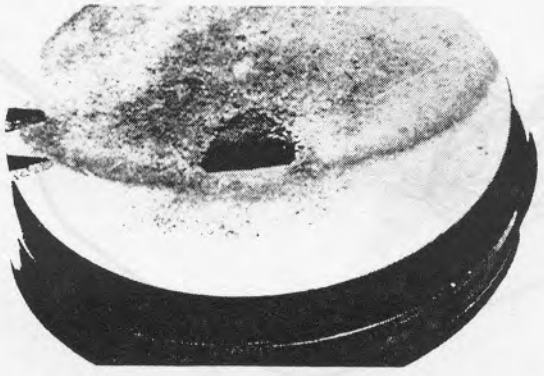
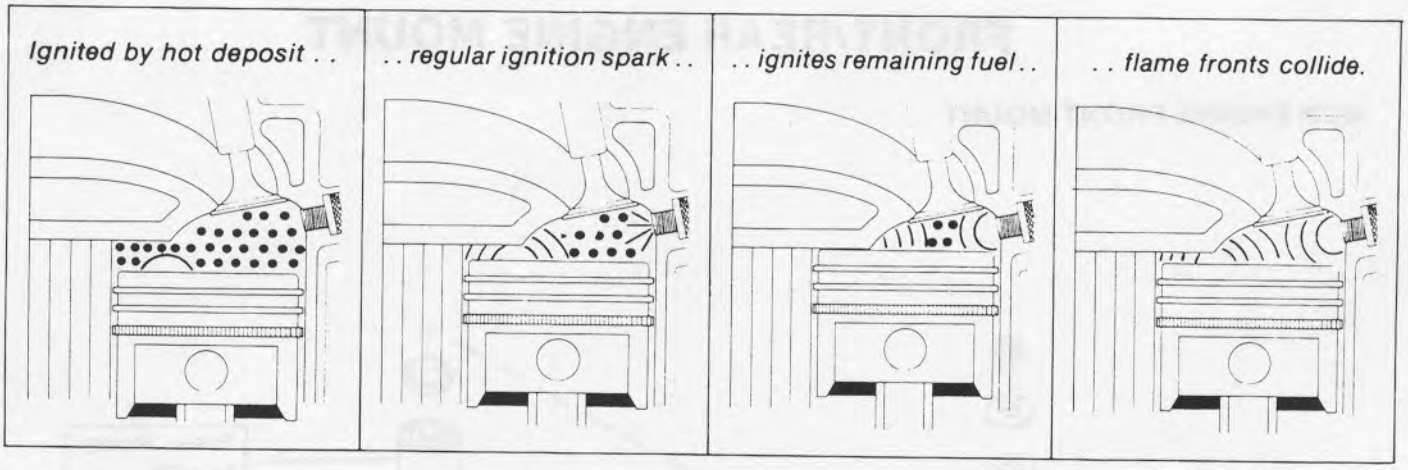


Figure 1. Pre-Ignition Damage



DETONATION

Detonation, commonly called "fuel knock", "spark knock" or "carbon knock", is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition. (Figure 2)

Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

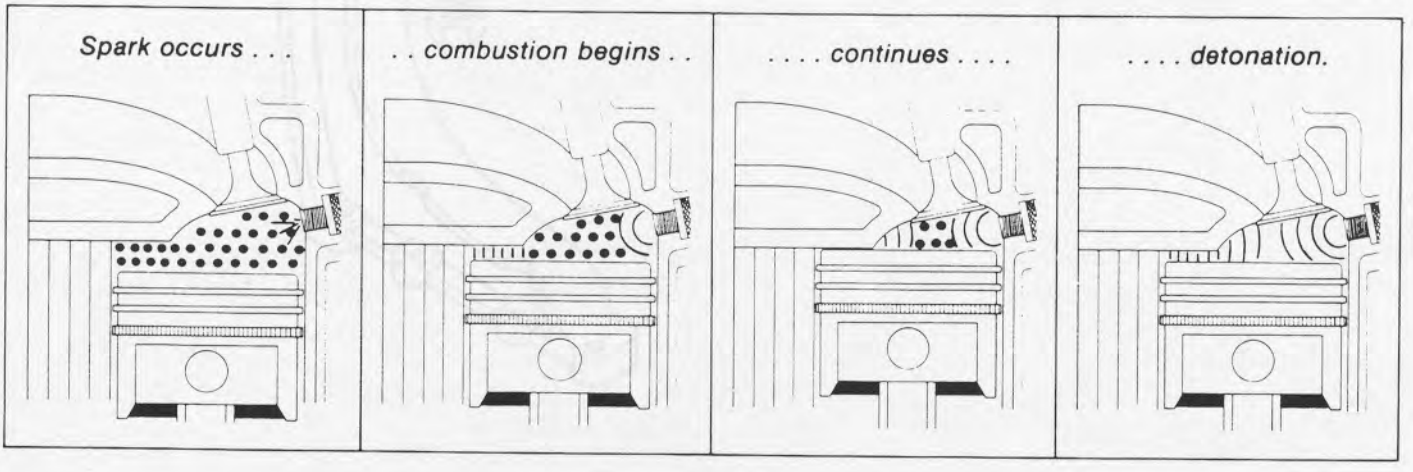
Other Causes of Detonation

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

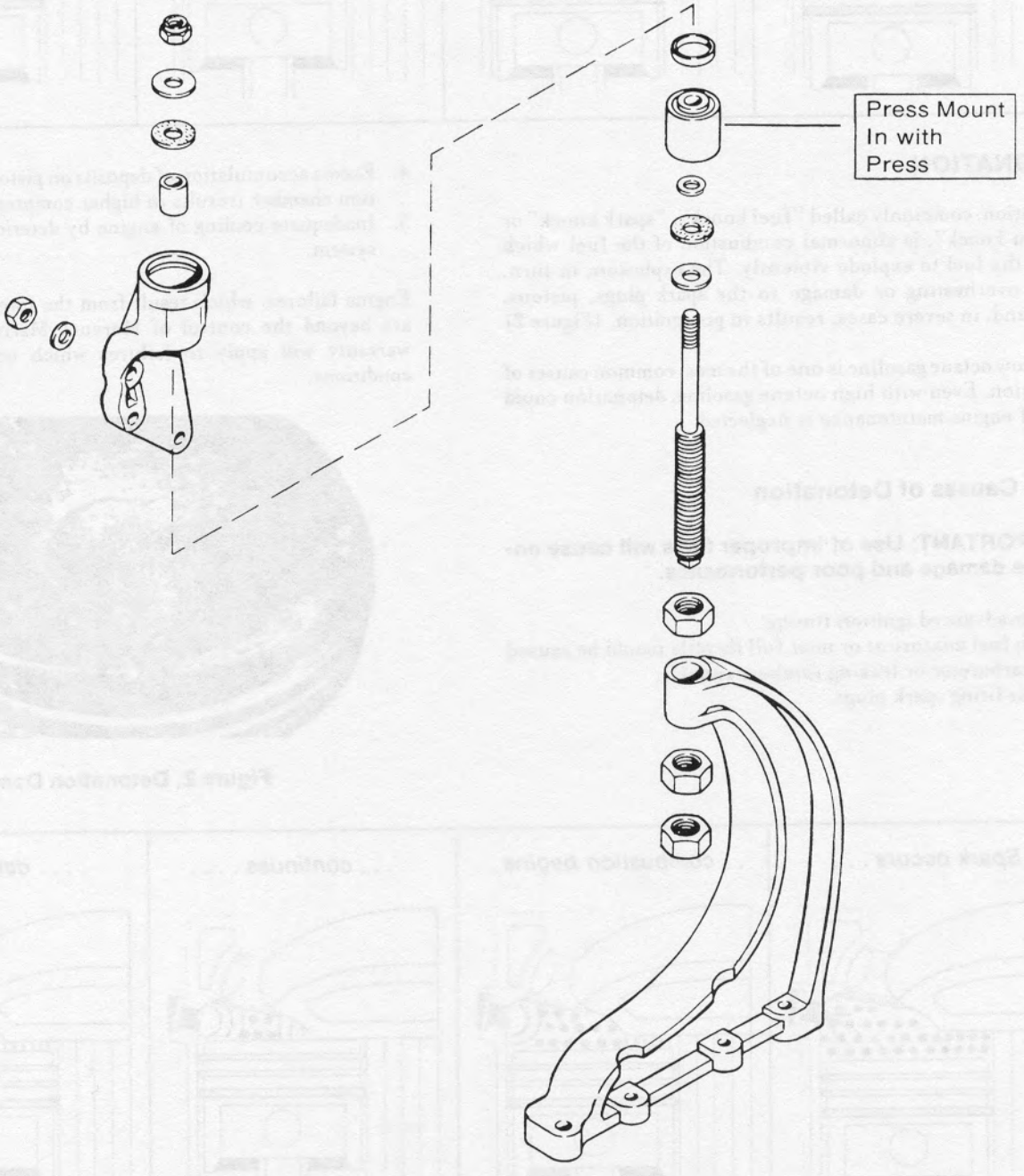
Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.

Figure 2. Detonation Damage



FRONT/REAR ENGINE MOUNT

MCM ENGINE FRONT MOUNT



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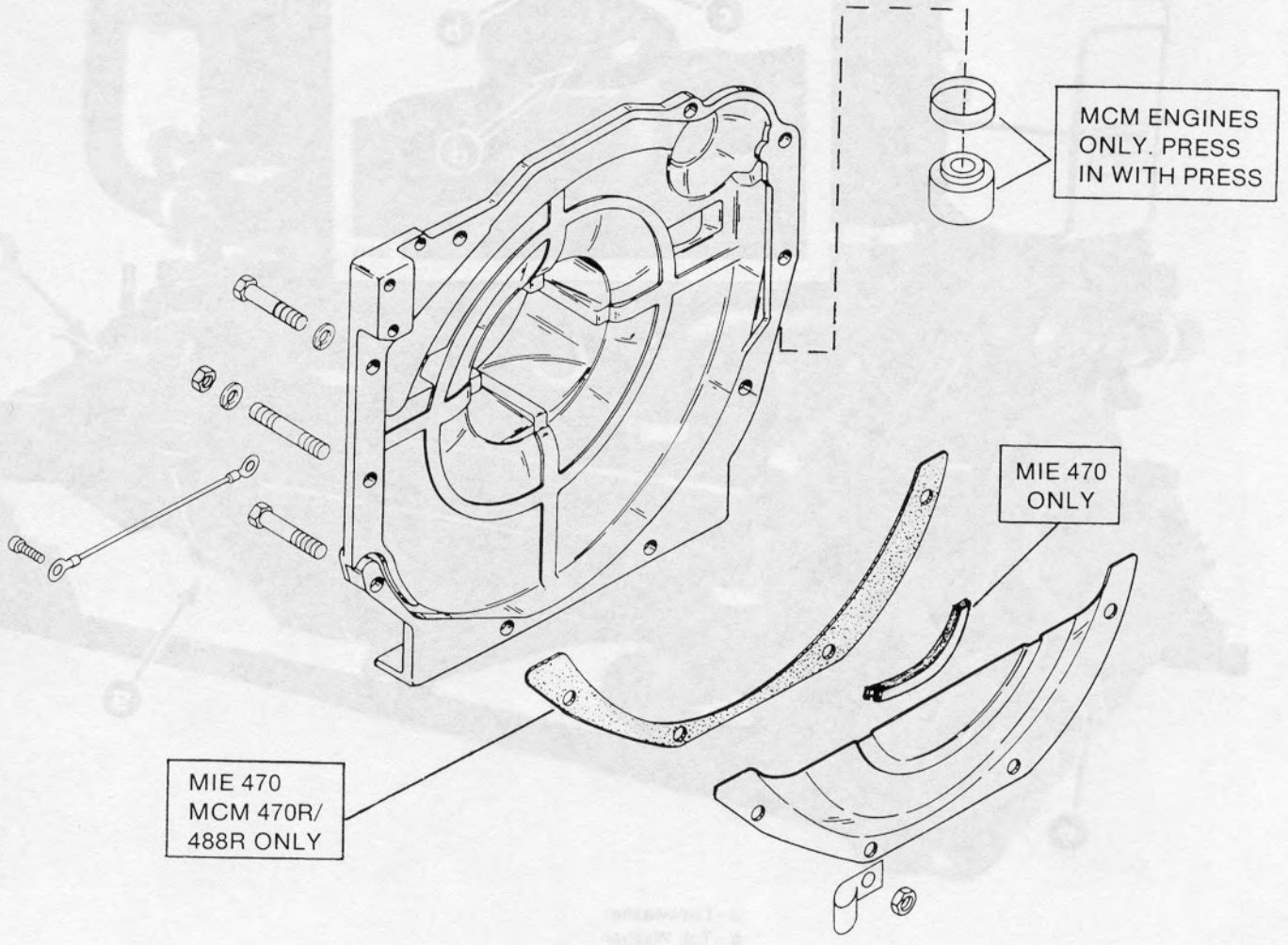
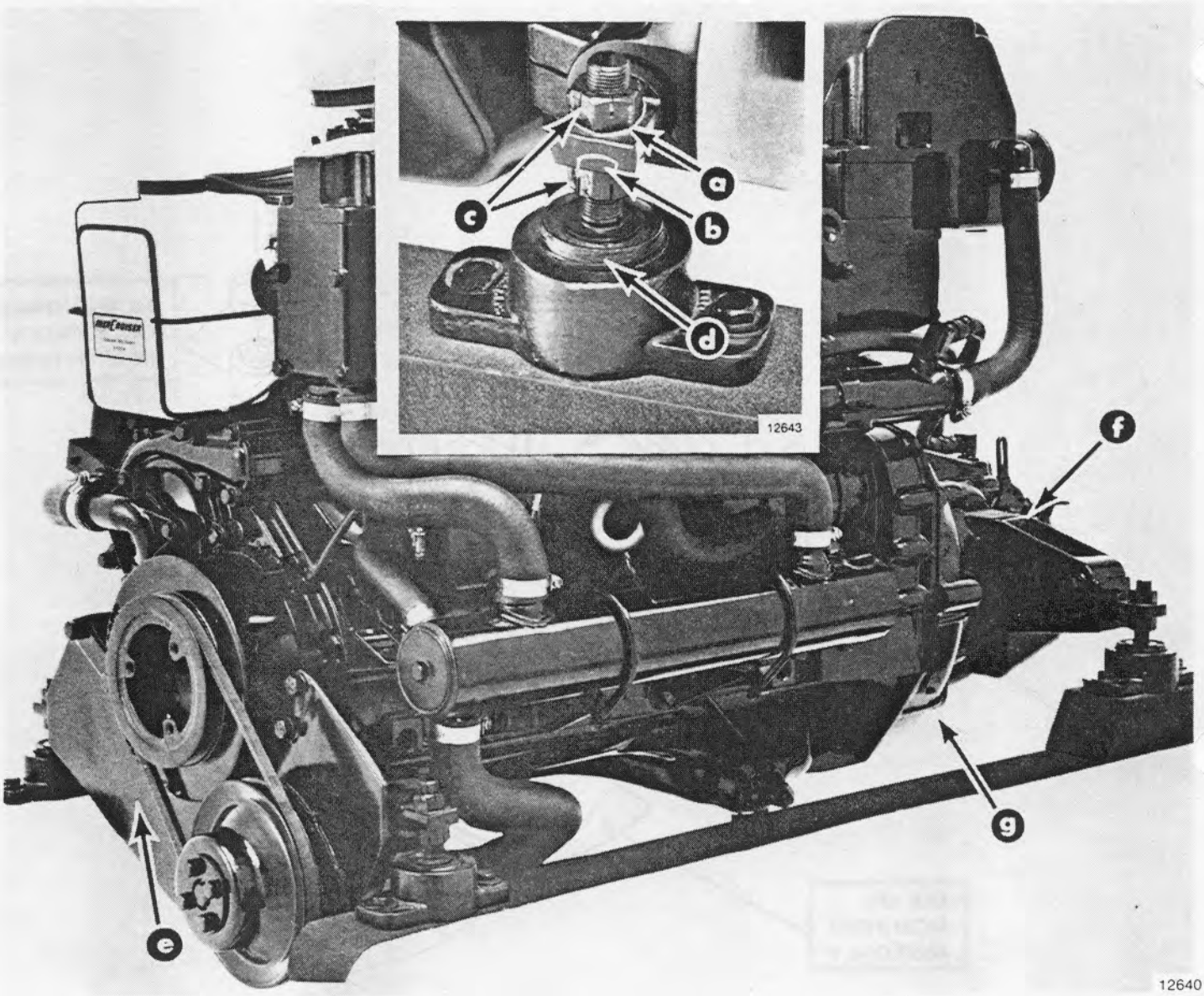
FLYWHEEL HOUSING/MCM ENGINE REAR MOUNTS





a - Lockwasher
b - Tab Washer
c - Nuts
d - Rubber Inset (Cannot Be Removed)
e - Front Engine Mount
f - Rear (Transmission) Mount
g - Flywheel Housing

INTAKE MANIFOLD

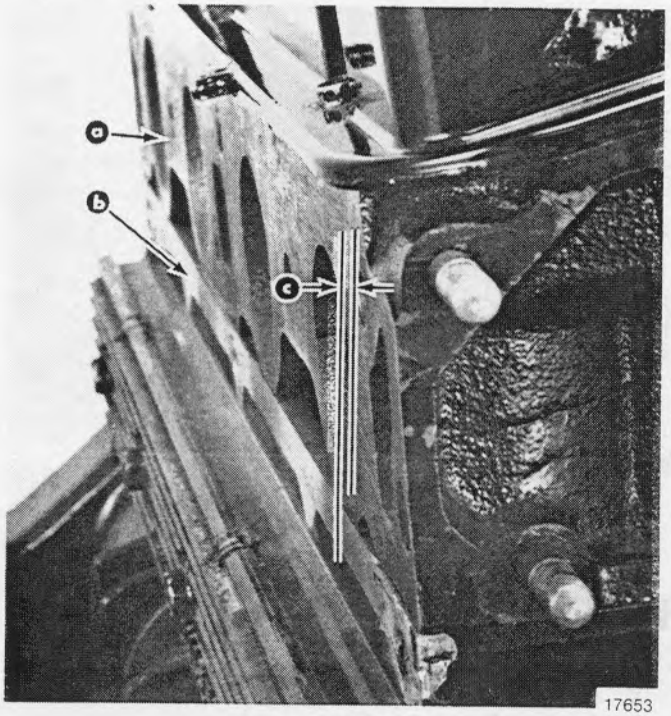
REMOVAL

1. Remove manifold assembly and discard gasket.
2. Carburetor may be removed from intake manifold, if necessary.

CLEANING/INSPECTION

1. Remove all gasket material.
2. Clean manifold in a suitable solvent and dry with compressed air.
3. Inspect manifold.
4. Inspect for misalignment of cylinder head and cylinder block. (Figure 1)

IMPORTANT: Gap must be within specification or engine oil may be drawn into intake manifold. This in turn will cause engine to burn oil.



a - Cyl. Head Surfcae
b - Cyl. Block Surface
c - Max. Gap .020" (.5mm)

Figure 1. Measuring Gap

5. If gap is more than specified, do either "a", "b" or "c".
   a. Remove cylinder head. Using new head gasket, reposition head until gap is within specifications.
   b. Use RTV Sealer on low surface, then put manifold gasket on.
   c. Replace cylinder head and recheck gap.

INSTALLATION

1. Apply Perfect Seal on both surfaces of intake manifold to cylinder head gasket. Position new gasket and intake manifold on cylinder head. Install fastener bolts with flat washers. (Figure 2) Torque fasteners to specifications.
2. Use new gasket and install carburetor, if removed. Torque fasteners to specifications.
3. Connect the following:
   a. Water hoses to manifold.
   b. Fuel line to carburetor.
   c. Crankcase breather hose to flame arrestor.
   d. Fuel pump vent tube to carburetor.
   e. Carburetor linkage to manifold. Lubricate swivel points.
   f. Throttle cable.
   g. Connect wires to choke cover.
4. Pressure check the cooling system, using automotive radiator cap tester. Follow tool manufacturer's instructions.

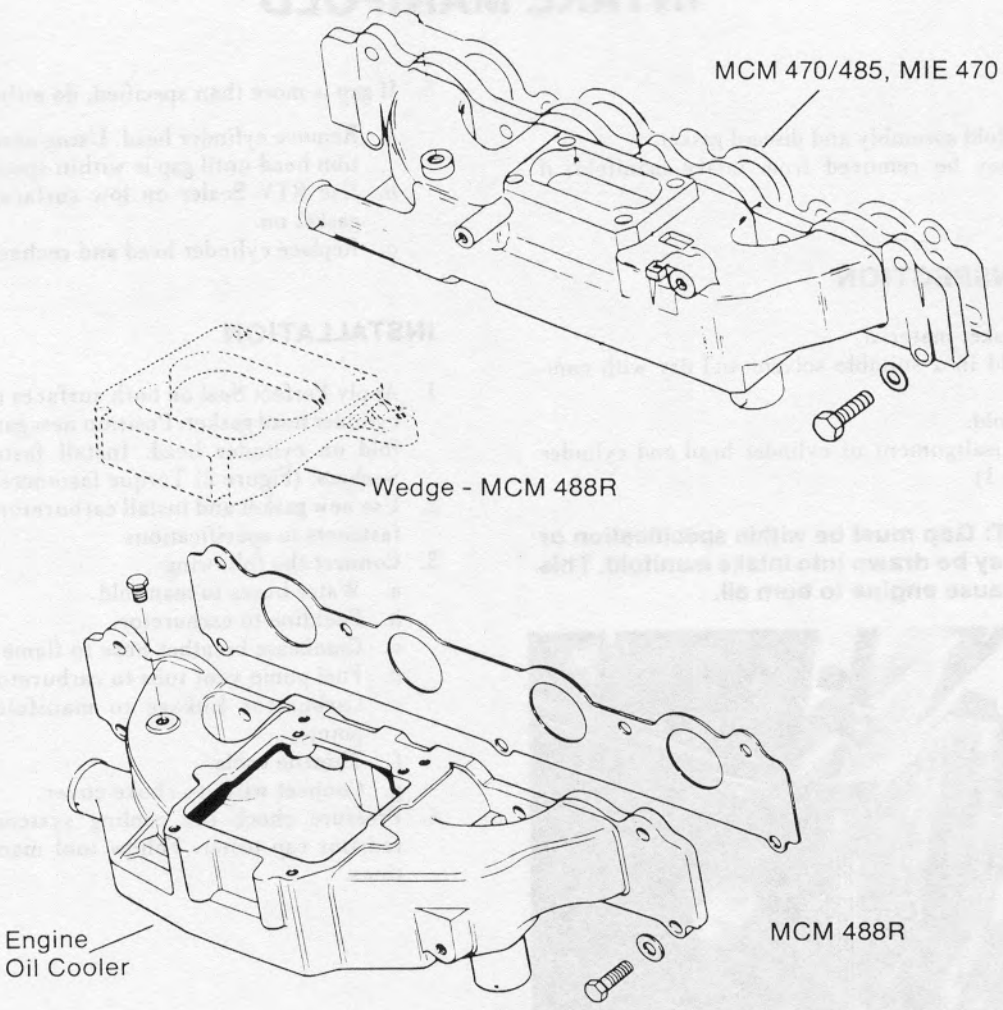


Figure 2. Intake Manifolds

ROCKER ARM COVER

REMOVAL

1. Remove spark plug leads.
2. Disconnect crankcase ventilation hose at rocker arm cover.
3. Remove throttle cable (some models).
4. Remove attaching bolts.
5. Remove rocker arm cover and gasket.

CLEANING and INSPECTION

1. Wash cover in solvent and dry with compressed air.
2. Remove all gasket material.
3. Inspect all gasket surfaces.

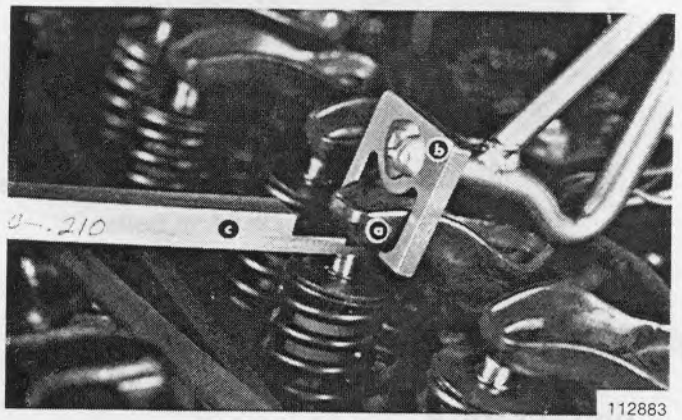
INSTALLATION

1. Use a new gasket and install rocker arm cover and torque to specifications.
2. Connect all parts previously removed.

VALVE CLEARANCE

IMPORTANT: Valve clearance is not adjustable. If clearance is not correct, it will be necessary to change the push rod to one of the correct length so that proper clearance can be achieved. Read instructions COMPLETELY BEFORE checking clearance to prevent bending push rods.

1. With No. 1 piston at TDC (firing), check clearance of following valves (Figure 1):
   - No. 1 - Intake and Exhaust
   - No. 2 - Intake
   - No. 3 - Exhaust
   - No. 4 - Intake



a - Rocker Arm
b - T711P-6513A Tool
c - Measure Clearance

Figure 1. Checking Valve Clearance

   a. Install tool as shown. Firmly push on handle until lifter is completely collapsed.
   b. Refer to "Specifications" for correct clearance (distance between end of valve stem and face of rocker arm).
   c. If clearance is less than specified, install a shorter push rod than was originally in engine. If clearance is more than specified, install a longer push rod.
   d. After installing new push rod, recheck valve clearance.

ENGINE PUSH ROD LENGTHS

Lengths	Color Code	Mercury Marine Part Number
8.595"-8.625" (218.313-219.075mm)	None or Red	67502-3
8.625"-8.655" (219.075-219.837mm)	None	67502-5
8.655"-8.685" (219.837-220.599mm)	Blue	67502-4
8.685"-8.715" (220.599-221.361mm)	Yellow	67502-6

2. Rotate crankshaft 360° (1 complete revolution) and check clearance of following valves:
   - No. 2 - Exhaust
   - No. 3 - Intake
   - No. 4 - Exhaust

ROCKER ARM/PUSH ROD

REMOVAL

1. Remove rocker arm cover.

IMPORTANT: Place rocker arms, rocker arm fulcrums and push rods in a rack so that they may be reinstalled in same location.

2. Remove rocker arm bolts, fulcrums, rocker arms and push rods.

CLEANING and INSPECTION

1. Clean parts in solvent and dry with compressed air.
2. Inspect each rocker arm for wear. Replace worn rocker arms.
3. Check push rod ends and fulcrum for excessive wear. Replace if necessary.
4. Check push rods for bent condition.

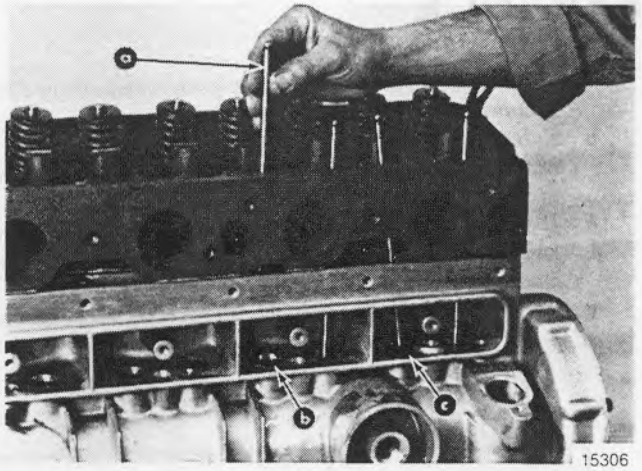
INSTALLATION

1. Install push rods. Be sure that push rods seat in lifter socket. (Figure 1)
2. Lubricate fulcrums and rocker arms with engine oil or Engine Oil Supplement. Install rocker arms, fulcrums and rocker arm fastening bolts. DO NOT tighten bolts at this time.

IMPORTANT: Torquing of rocker arm bolts (Step 3) and checking valve clearance (preceding) are both done with valve in closed position. Time can be saved by completing both of these steps at the same time.

⚠CAUTION

Push rods may become bent, if the following rocker arm torque procedure is not completed. Refer to "Valve Clearance" for correct sequence.



a - Push Rod
b - Lifter (Note Socket)
c - Push Rod Installed into Lifter Socket

Figure 1. Installing Push Rod

3. With No. 1 piston at TDC (firing), torque rocker arm bolts (to specifications) as outlined in Step 1 of "Valve Clearance". (Figure 2)
4. Rotate engine 360° (1 complete revolution) and torque remaining rocker arm bolts to specifications. Refer to Step 2 of "Valve Clearance" for remaining rocker arms.
5. Install rocker arm cover.

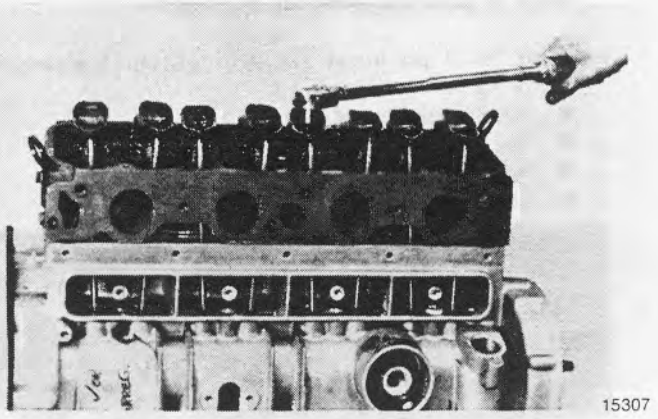
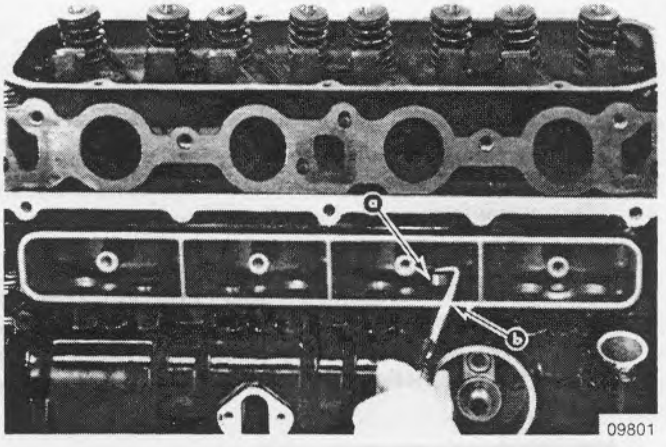


Figure 2. Torquing Rocker Arm Bolts

HYDRAULIC VALVE LIFTERS

REMOVAL

1. Remove rocker arm cover.
2. Remove valve mechanism.
3. Remove bolts with "O" rings and remove side cover.
4. Lift out lifters. (Figure 1) Place lifters in order so that lifter will be reinstalled in same location.



a - Lifter b - Pointed Tool

Figure 1. Removing Hydraulic Valve Lifters

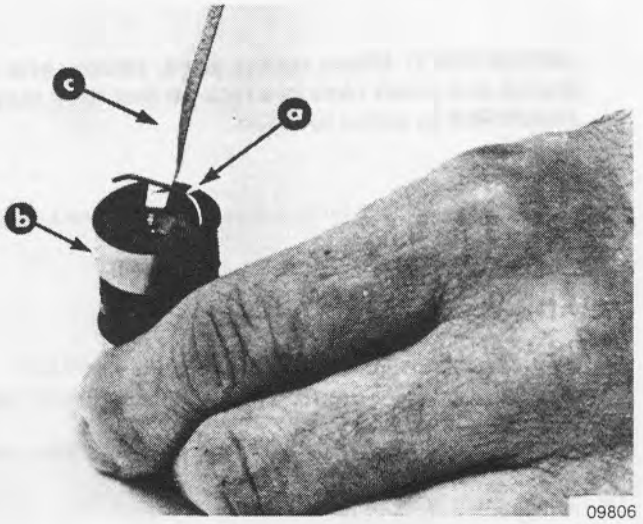
a - Lockring b - Lifter Assembly c - Small Screwdriver

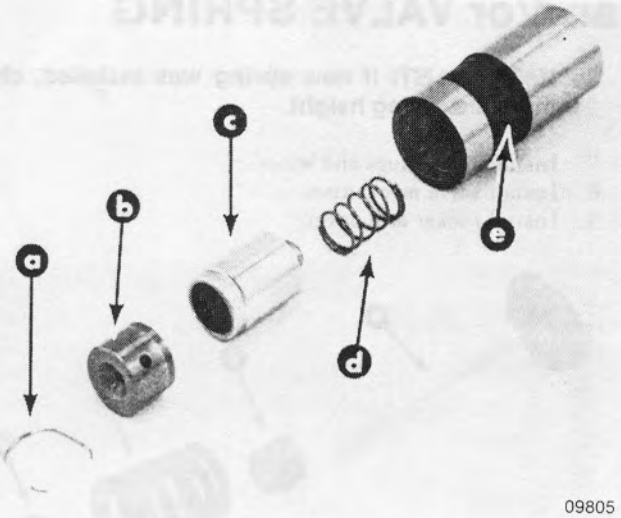
Figure 2. Removing Lockring

DISASSEMBLY

IMPORTANT: Lifters can be disassembled, cleaned and reinstalled. If any parts are worn, lifter must be replaced as an assembly.

1. Use small screwdriver or needle-nose pliers to remove lockring. (Figure 2)
2. Lightly tap top end of lifter assembly on flat surface to remove push rod cup, plunger/check valve assembly and spring. (Figure 3)





a - Lockring
b - Push Rod Cup
c - Plunger/Check Valve Assembly
d - Plunger Spring
e - Lifter Body

Figure 3. Lifter Components

CLEANING and INSPECTION

1. Thoroughly clean all parts in cleaning solvent and dry them with compressed air.
2. Carefully inspect all parts for wear. If any parts are damaged or worn, entire lifter assembly must be replaced. If outside of lifter body is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is worn, inspect camshaft lobe. If push rod seat is worn, inspect push rod.

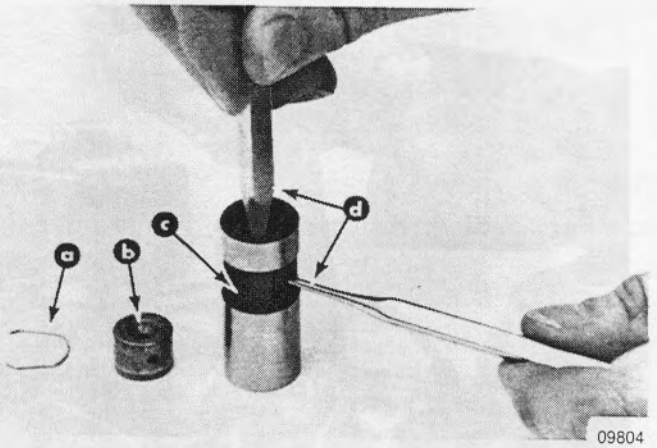
REASSEMBLY

IMPORTANT: Work in clean area.

1. Inject engine oil in lifter body to approximately ½-full.
2. Set plunger spring in lifter body. (Figure 3)
3. Place plunger assembly (check valve end down) in lifter body. (Figure 3)
4. Use small punch to unseat check ball (located in bottom of plunger assembly) and push plunger (compressing spring) until top of plunger is below hole in side of lifter body. (Figure 4) Now insert small punch through side hole to hold plunger in position.
5. Remove punch from check ball and position push rod cup in lifter body.
6. Install lockring in groove and remove punch from lifter body side hole.

INSTALLATION

1. Lubricate all camshaft lobes, lifter bores and entire lifter with G.M. Engine Oil Supplement or engine oil.
2. Replace lifter into lifter bore from which it was removed.
3. Install valve mechanism.
4. Install cover, using new gasket and new "O" rings on cover attaching bolts. Torque to specifications.
5. Install rocker arm cover.



a - Lockring
b - Push Rod Cup
c - Lifter Body
d - Small Punches

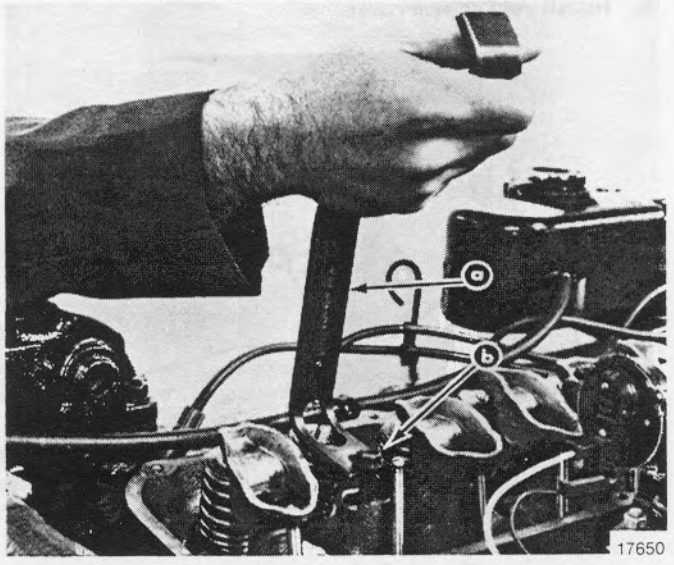
Figure 4. Assembling Lifter

VALVE STEM OIL SEAL and/or VALVE SPRING

1. Remove rocker arm cover.
2. Remove spark plugs.
3. Remove rocker arm bolt, fulcrum, rocker arm and push rod on cylinder to be serviced.
4. Position piston at top dead center to prevent valve from dropping out of valve guide.

   NOTE: A tool to apply air to cylinder is available thru local jobbers. Engines use tapered spark plugs.

5. Install rocker arm bolt (from where bolt was removed) and position compressor tool as shown in Figure 5. Compress valve spring and remove retainer locks. Remove tool, then remove retainer, valve spring and seal. (Figure 6)
6. Install new valve stem seal. Place spring in position over valve and install valve spring retainer. Compress valve spring and install spring retainer locks. (Figure 5) Remove compressor tool and bolt.

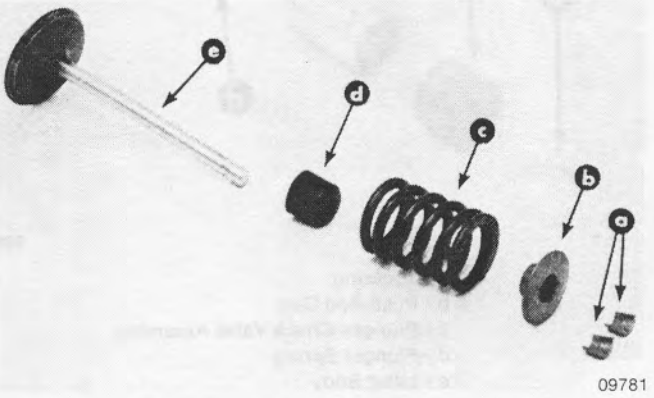


a - J-5892-1 Tool
b - Rocker Arm Bolt

Figure 5. Compressing Valve Spring

IMPORTANT: If new spring was installed, check installed spring height.

7. Install spark plugs and wires.
8. Install valve mechanism.
9. Install rocker arm cover.



a - Retainer Locks
b - Spring Retainer
c - Valve Spring
d - Seal
e - Valve

Figure 6. Valve and Related Parts

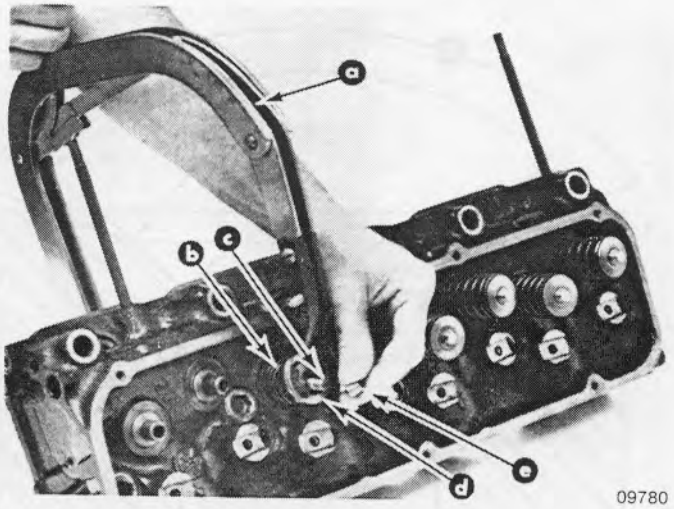
CYLINDER HEAD and VALVES

CYLINDER HEAD REMOVAL

1. Remove intake and exhaust manifold.
2. Remove rocker arm cover and valve mechanism.
3. Disconnect spark plug wires and remove spark plugs and coil bracket.
4. Disconnect water hose.
5. Remove bolts, then remove cylinder head assembly and gasket.

VALVE REMOVAL

1. Remove cylinder head.
2. Compress valve springs (Figure 1) with valve spring compressor and remove retainer locks.
3. Remove spring compressor tool, spring retainer, valve spring, valve stem seal and valve. Identify all valves to reinstall in same location.
4. Repeat Steps 2 and 3 to remove each valve.

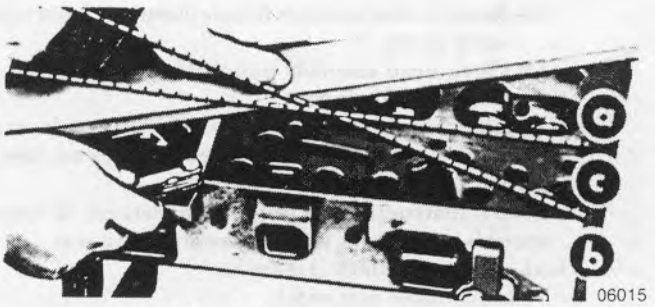


a - J-8062 Tool
b - Valve Spring
c - Valve Stem
d - Spring Retainer
e - Retainer Locks

Figure 1. Removing and/or Installing Valves

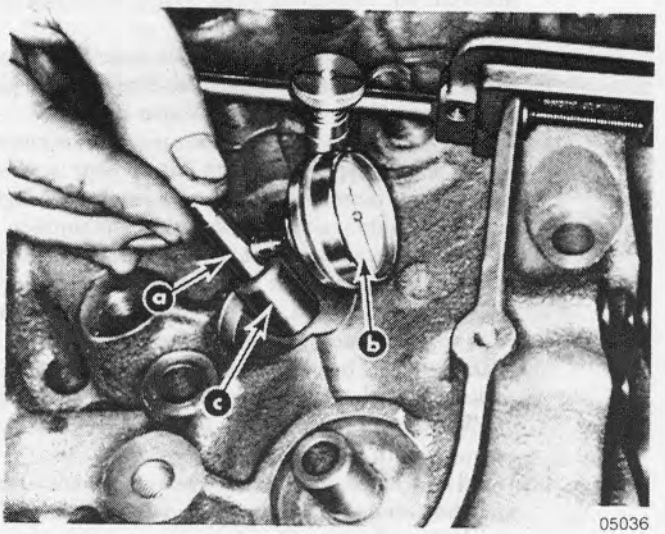
CYLINDER HEAD CONDITIONING

1. Remove deposits from combustion chambers with Tool J-8089.
2. Clean all gasket surfaces.
3. Thoroughly clean valve guide bores with valve guide cleaning tool.
4. Clean all bolts and bolt holes.
5. Check cylinder head for cracks and inspect gasket surface for burrs and nicks.
6. Check cylinder head for flat gasket surface (Figure 2). (See "Specifications".) If necessary to refinish cylinder head gasket surface, do not plane more than .010" (.25mm).



a - Check Diagonally
b - Check Diagonally
c - Check Across Center

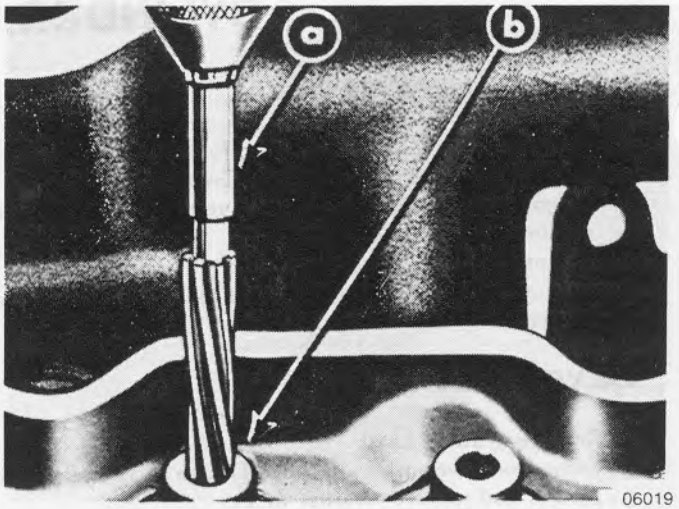
Figure 2. Typical Cylinder Head Flatness



a - Valve Stem
b - Dial Indicator
c - Valve Guide

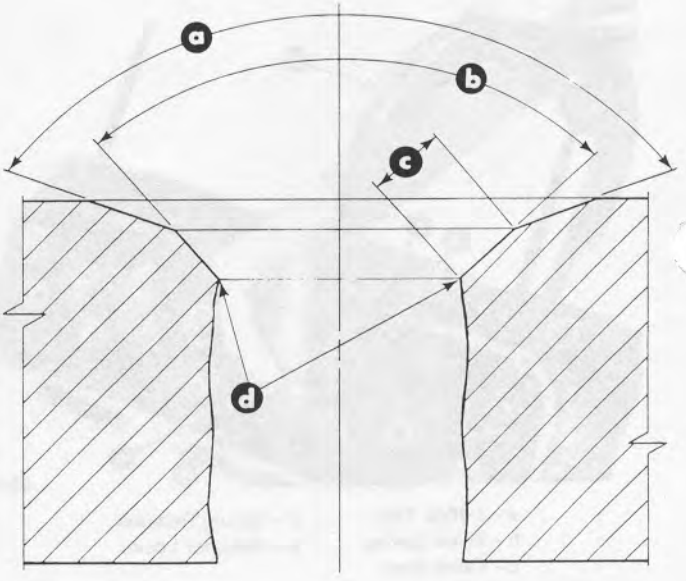
Figure 3. Checking Valve Stem Clearance

7. Measure valve stem clearance (Figure 3) as follows:
   a. Clamp dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side-to-side (crosswise to head) will cause direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide. (Figure 3)
   b. With valve head dropped about 1/16" (2mm) off valve seat, move valve stem from side-to-side.
   c. If clearance exceeds specifications, it will be necessary to ream valve guides for next oversize valve (Figure 4):
      (1) Valve guide to be reamed must be refinished before doing any checking or refacing of valve seat.
      (2) After guide is refinished, seat also must be refaced to match guide.
      (3) Always use reamers in sequence (starting with smallest oversize reamer) when going from standard valve stem to an oversize.
      (4) Remove sharp corner (inside diameter) from top of valve guide.
      (5) Clean head assembly thoroughly.
8. Check valve seat for runout.
   a. Install accurate gauge on tool positioned in valve stem guide. It is essential that valve guide bores are free of carbon or dirt.
   b. Follow instructions of gauge manufacturer. If runout exceeds wear limit, reface valve and valve seat.
9. Check valve seat width (Figure 5).
   a. Measure valve seat width.
   b. Reface valve seat, if width is not within specifications.
      (1) Closely coordinate refacing valve seat with refacing valve face so that finished seat and valve face are concentric, and specified interference fit will be maintained. This is important so that valve and seat have compression-tight fit.
      (2) Grind valve seats to correct angle (see "Specifications"). Remove only enough stock to clean up pits and grooves or to correct valve seat runout.
      (3) Finished valve seat must contact appropriate center of valve face. Apply ink (with felt tip pen) to refinished valve face. Install valve and rotate with light pressure. Remove valve and check seat contact. If seat contacts center of valve face, contact is satisfactory. If seat contact is at top edge of valve face, lower the valve seat. If seat contact is at bottom edge of valve face, raise the valve seat.
      (4) After seat has been refaced, recheck seat width. If width exceeds maximum limit, remove enough stock from top edge and/or bottom edge of seat to reduce width to specifications.
      (5) If valve and/or seat has been refaced, check clearance between rocker arm seat and valve stem. Refer to "Valve Clearance".



a - T52L-6085-AEE Tool b - Valve Guide

Figure 4. Reaming Valve Guides



a - Top Edge "Approach Angle"
b - Seat Angle
c - Seat Width
d - Bottom Edge

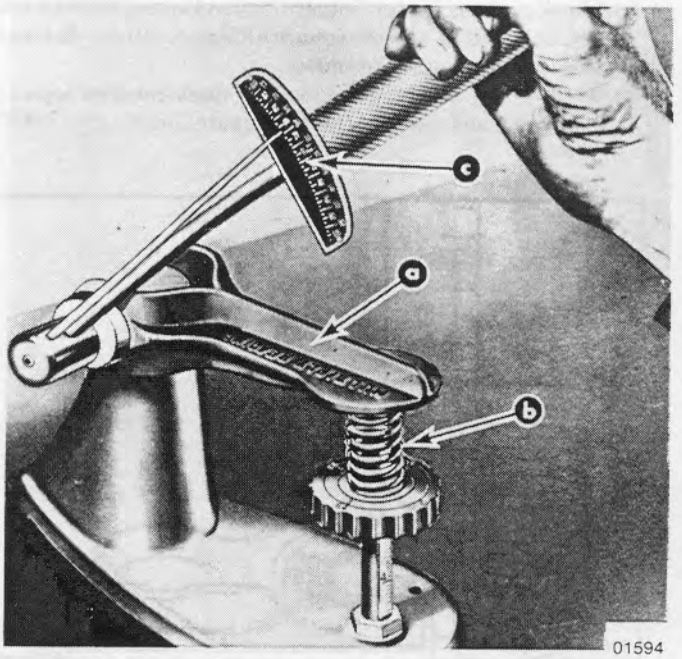
Figure 5. Valve Seat in Cylinder Head

VALVE CONDITIONING

1. Clean deposits from valve head and stem.
2. Closely coordinate valve refacing operation with valve seat refacing operations so that finished angles of valve face and valve seat will meet specifications and provide compression-tight fit.
3. See "Specifications", for valve face angle. Remove only enough stock to correct runout or to clean up pits and grooves. If edge of valve head is less than 1/32" (.8mm) thick after grinding, replace valve.
4. If valve and/or seat has been refaced, check clearance between rocker arm seat and valve stem. Refer to "Valve Clearance".

VALVE SPRING INSPECTION

1. Check springs for correct pressure at specified spring lengths with Tool J-8056. (Figure 6) Follow tool manufacturer instructions.
2. Replace any spring not within specifications.



a - J-8056 Tool b - Valve Spring c - Torque Wrench

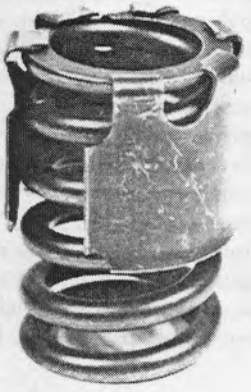
Figure 6. Checking Valve Spring Pressure

17648

Figure 7.
470 Spring,
Orange Stripe

17649

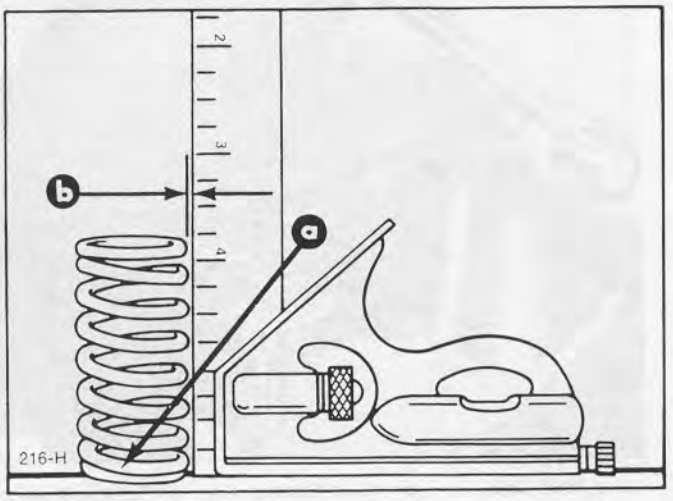
Figure 8.
485 Spring,
Red or Blue Stripe



17651

Figure 9.
488 Spring,
Green Stripe

3. Check each spring for "square". Stand spring (closed coil end downward) and steel square (Figure 10) on flat surface. Slide spring up to square.
4. Revolve spring slowly and observe space between top coil of spring and square. Out-of-square limits are 5/64" (2mm).

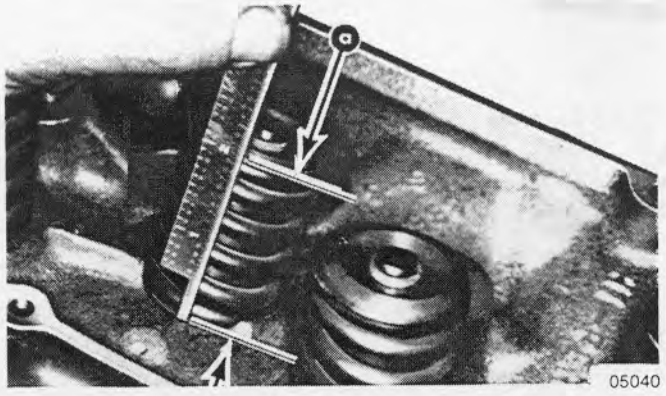


a - Valve Spring Closed Coil End b - Max. 5/64" (2mm)

Figure 10. Checking Valve Spring Squareness

VALVE INSTALLATION

1. Lubricate valve stem and valve stem guide with Engine Oil Supplement. Install each valve in port from which it was removed or to which it was fitted.
2. Install new stem seal on valve.
3. Install valve spring over valve, then install spring retainer.
4. Compress spring (using compressor tool) and install retainer locks. Make sure that locks are positioned properly in valve stem groove.
5. Measure assembled height of valve spring from surface of cylinder head spring seat to underside of spring retainer. (Figure 11) If assembled height is greater than specifications, install spacer(s) below spring to reduce height to recommended dimension. DO NOT overshim.



a - See Specifications

Figure 11. Measuring Spring Height

CYLINDER HEAD INSTALLATION

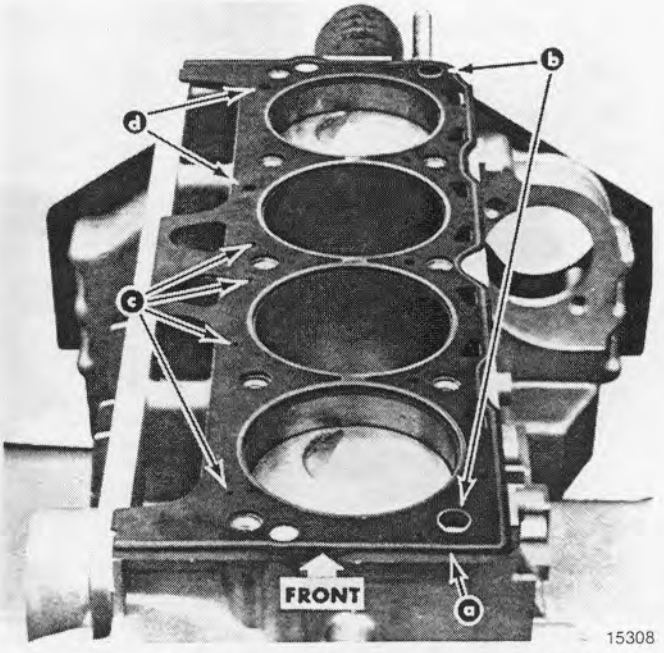
NOTICE

Low Compression Cylinder Head Gasket Kit (27-94954A1) lowers compression ratio from 8.8:1 to 8.2:1. Also basic timing must be lowered from 8° BTDC to 2° BTDC. This kit was primarily designed for use in countries outside the U.S.A. and Canada, where the fuel octane rating may be low.

1. Be sure that all gasket surfaces are clean.

   IMPORTANT: DO NOT use any gasket cement or sealer on Head Gasket, Cylinder Head or Cylinder Block.

2. Position new cylinder head gasket on cylinder block with the word FRONT (stamped on gasket) toward front of engine and facing DOWN toward cylinder block (Figure 12). Make sure alignment dowel pins are through correct holes in head gasket.



a - Cylinder Head Gasket
b - Alignment Dowel Pins
c - Small Water Passage Holes
d - Large Water Passage Holes

Figure 12. Cylinder Head Gasket Installation

IMPORTANT: Check alignment of cylinder head and cylinder block as outlined under "Intake Manifold".

3. Coat threads and underside of bolt head with Perfect Seal and install cylinder head bolts.

⚠CAUTION

Failure to properly torque cylinder head bolts will result in very short head gasket life. Cylinder head bolt holes (located in cylinder block) must be free of water or oil when installing cylinder head fastening bolts. Block failure may occur from hydraulic pressure buildup while torquing cylinder head bolts.

4. Follow torquing sequence shown in Figure 13, torque cylinder head bolts in three steps:
   - 55 lbs. ft. (75 N.m)
   - 90 lbs. ft. (122 N.m)
   - 130 lbs. ft. (176 N.m)

IMPORTANT: Failure to properly torque cylinder head bolts can cause cylinder head gasket failure. Also, cylinder head bolts MUST be retorqued after engine has been brought to normal operating temperature. Failure to do this can result in head gasket failure.

5. Reinstall all components previously removed.

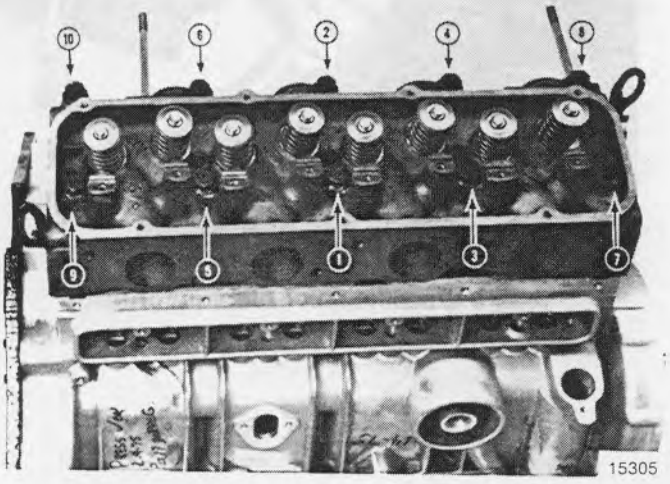
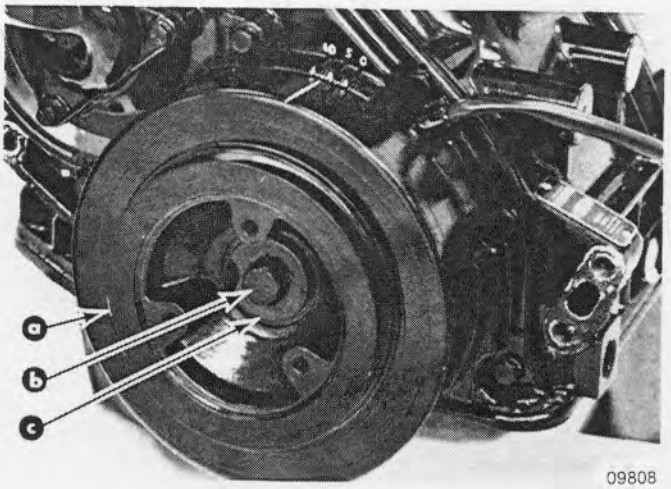


Figure 13. Cylinder Head Bolt Torquing Sequence

ALTERNATOR ROTOR

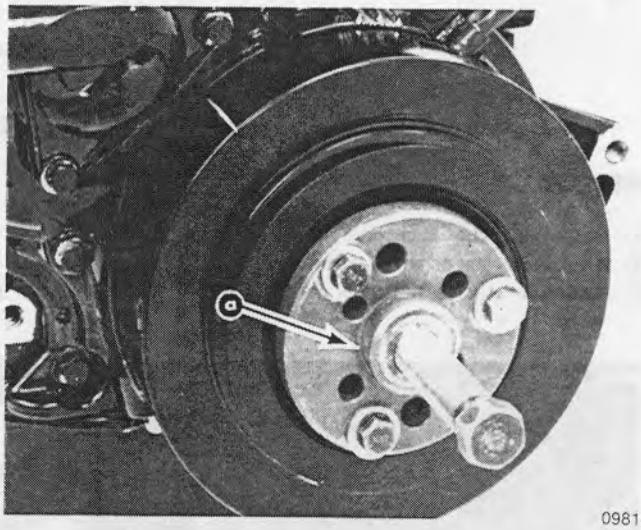
REMOVAL

1. Remove front engine mount assembly (if applicable).
2. Remove bolt from center of rotor (Figure 1) and remove washer from bolt.
3. Install Tool J-6978-04 and remove rotor assembly. (Figure 2) Use grease on tapered end of tool.
4. Measure oil seal area with micrometer, for undersize (see "Specifications").



a - Alternator Rotor b - Center Bolt c - Washer

Figure 1. Alternator Rotor



a - J-6978-04 Tool

Figure 2. Removing Alternator Rotor

INSTALLATION

1. Lubricate lip of oil seal and rotor surface (where oil seal rides) with engine oil.
2. Check that rotor locating key is properly installed in crankshaft groove.
3. Lubricate crankshaft end and inside diameter of rotor assembly with Chicago Manufacturing and Distribution Co. anti-scoring, extreme pressure Lubricant No. 3 or equivalent.
4. Position rotor assembly onto crankshaft, aligning key slot in rotor with key located on crankshaft.
5. Install Tool J-21058-20 into crankshaft end. Hold tool center shaft from turning and turn large nut to install rotor (Figure 4) until rotor bottoms out.

⚠CAUTION

DO NOT use hammer to drive rotor on, as this can loosen magnets in rotor.

6. Install rotor fastening bolt and washer and torque bolt to specifications.

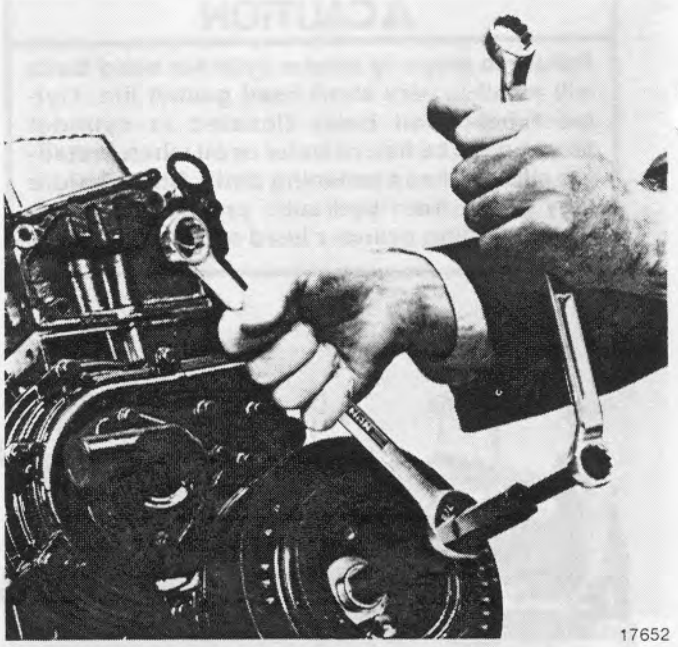


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Figure 4. Installation of Alternator Rotor

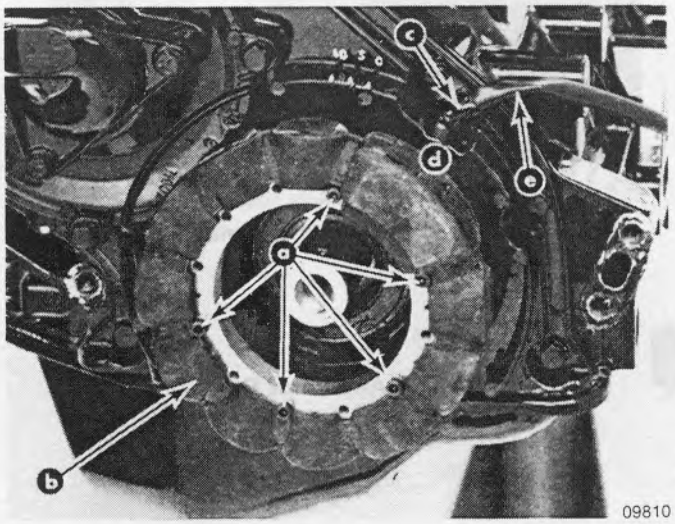
15230A

Figure 3. J-21058-20 Tool

STATOR

REMOVAL

1. Remove alternator rotor.
2. Disconnect stator wires from regulator.
3. Remove stator fastening screws and remove stator. (Figure 5)



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a - Stator Screws
b - Stator
c - Clamp
d - Cover Recess
e - Stator Wires

Figure 5. Stator Assembly on Engine

INSTALLATION

1. Position stator onto front cover with output wires toward recess cast in cover. (Figure 5)
2. Apply Loctite "A" on screw threads, install screws and torque to specifications.
3. Reconnect stator wires to regulator.
4. Install alternator rotor.

FRONT COVER and CIRCULATING PUMP

REMOVAL

IMPORTANT: Oil pan gasket must be replaced whenever front cover is removed.

1. Remove front engine mount (if applicable).
2. Remove alternator rotor and stator.
3. Remove parts as shown in Figure 6. (Early 470, refer to Figure 7 also.)
   - Impeller bolt - right-hand thread.
   - Impeller nut - left-hand thread.
4. Drive out oil seals.

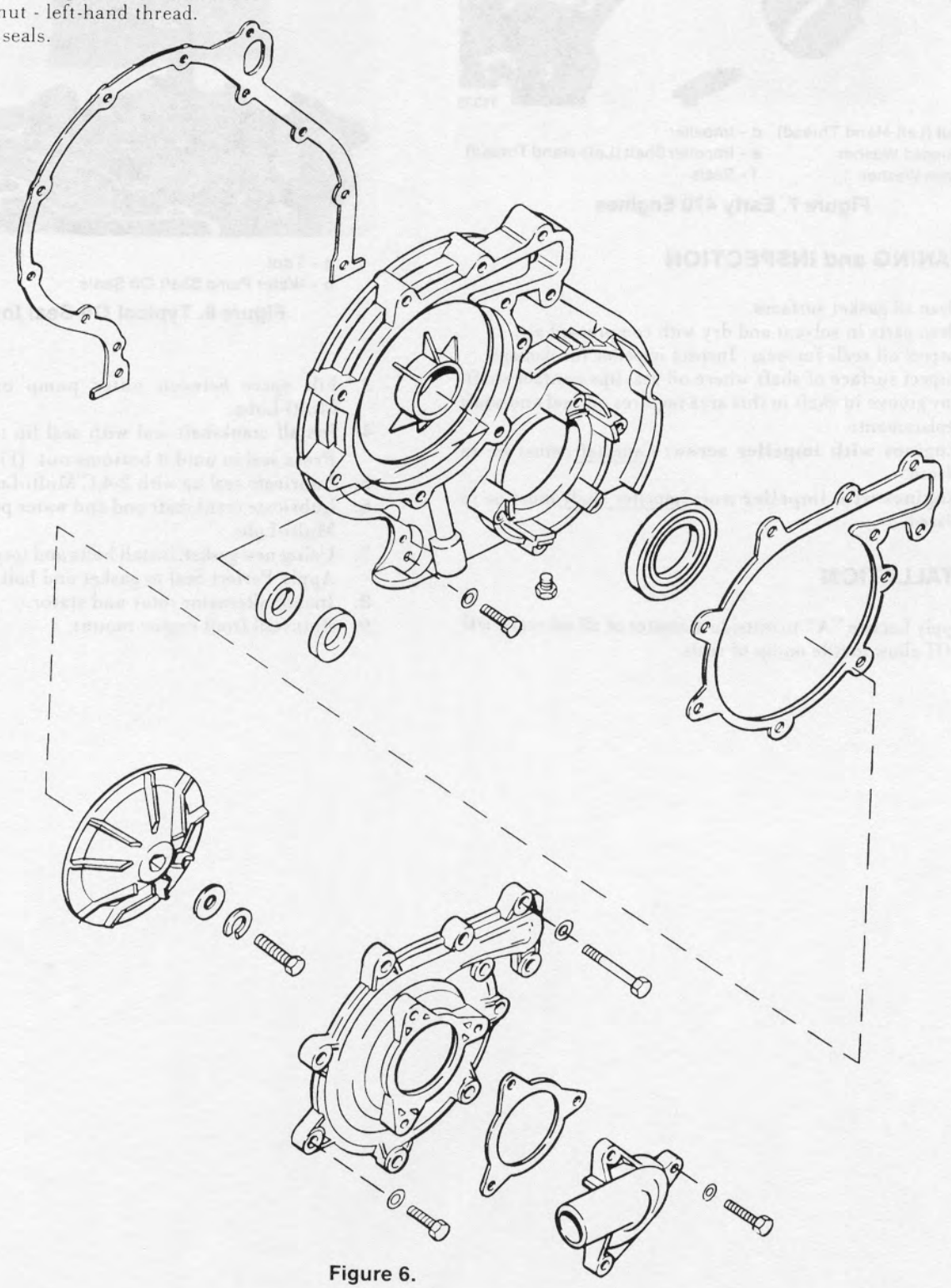
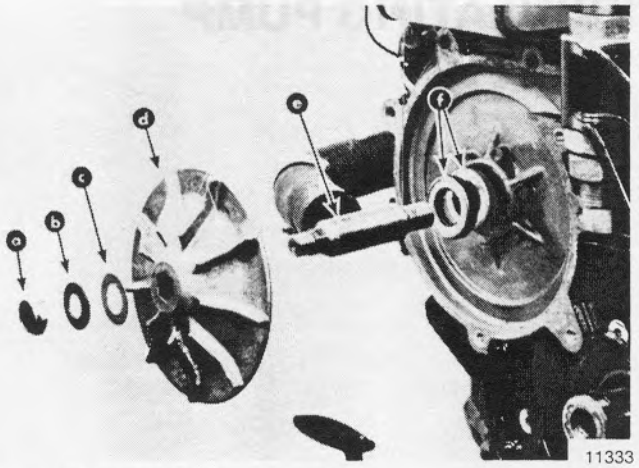


Figure 6.



a - Nut (Left-Hand Thread)
b - Cupped Washer
c - Shim Washer
d - Impeller
e - Impeller Shaft (Left-Hand Thread)
f - Seals

Figure 7. Early 470 Engines

CLEANING and INSPECTION

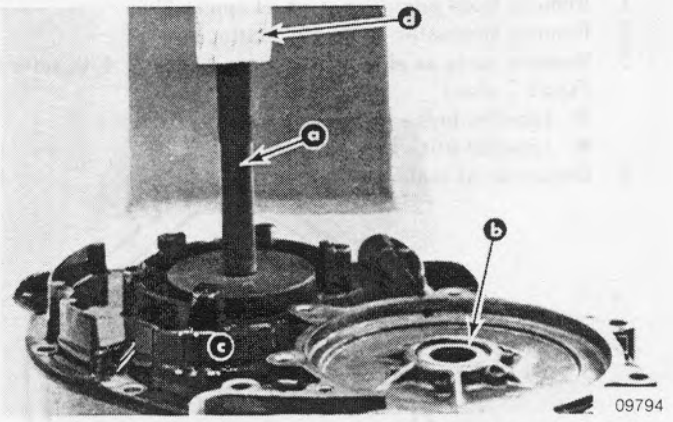
1. Clean all gasket surfaces.
2. Clean parts in solvent and dry with compressed air.
3. Inspect oil seals for wear. Inspect impeller for damage.
4. Inspect surface of shaft where oil seal lips contact shaft. Any groove in shaft in this area requires oil seal and shaft replacement.
   Engines with impeller screw: Camshaft must be replaced.
   Engines with impeller nut: Impeller shaft must be replaced.

INSTALLATION

1. Apply Loctite "A" to outside diameter of all oil seals. DO NOT allow loctite on lip of seals.

IMPORTANT: Support underside of cover when installing oil seals.

2. Both water pump seal lips face water side. First water pump seal is pressed in until it bottoms out; second seal is pressed in until even with cover surface. (Figure 8)



a - Tool
b - Water Pump Shaft Oil Seals
c - Front Cover
d - Arbor Press

Figure 8. Typical Oil Seal Installation

3. Fill space between water pump oil seals with 2-4-C Multi-Lube.
4. Install crankshaft seal with seal lip toward engine block. Press seal in until it bottoms-out. (Figure 8)
5. Lubricate seal lip with 2-4-C Multi-Lube.
6. Lubricate crankshaft end and water pump shaft with 2-4-C Multi-Lube.
7. Using new gasket, install bolts and torque to specifications. Apply Perfect Seal to gasket and bolt threads.
8. Install alternator rotor and stator.
9. Reinstall front engine mount.

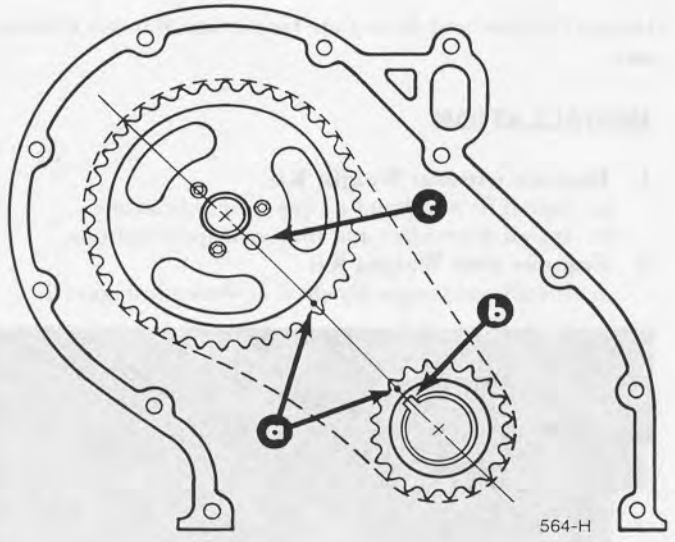
TIMING CHAIN and SPROCKETS

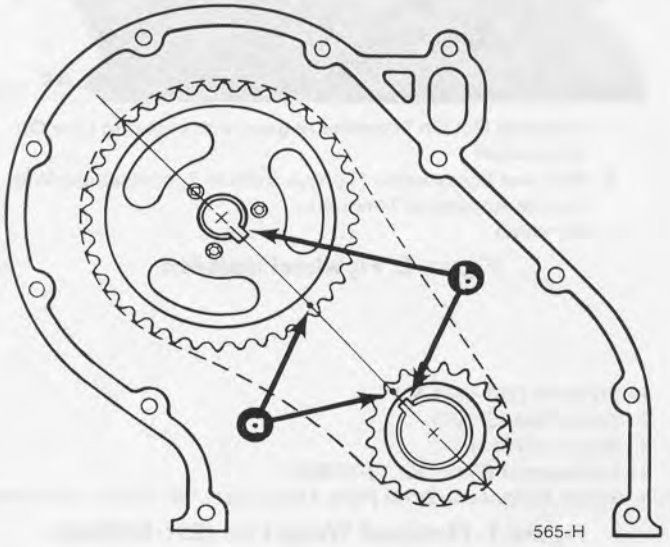
CHECKING TIMING CHAIN DEFLECTION

1. Rotate crankshaft in clockwise direction (as viewed from front) to take up slack on left side of chain.
2. Establish a reference point on cylinder block and measure from this point to chain.
3. Rotate crankshaft in opposite direction to take up slack on right side of chain. Force left side of chain out with fingers and measure distance between reference point and chain. Deflection is difference between the 2 measurements. If deflection exceeds 1″ (25mm), replace timing chain and inspect sprockets and tensioner for abnormal wear.

REMOVAL

1. Drain cooling system and crankcase.
2. Remove alternator rotor, stator and front cover.
3. Crank engine until timing marks on sprockets are positioned as shown in Figure 9.
4. Remove chain tensioner and camshaft sprocket attaching screws.
5. Slide both sprockets and timing chain forward and remove as an assembly.



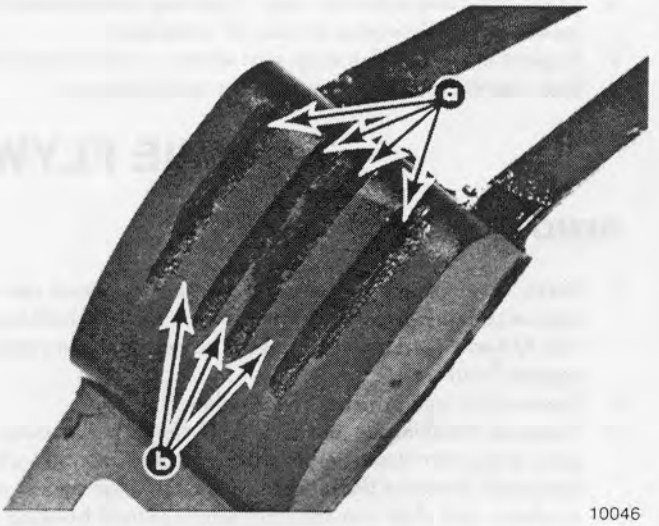


a - Timing Marks
b - Sprocket Key
c - Sprocket Pin

Figure 9. Timing Chain and Sprockets

CLEANING and INSPECTION

1. Clean all parts in solvent and dry with compressed air.
2. Inspect chain.
3. Inspect sprockets for damaged teeth.
4. Inspect chain tensioner for wear. If chain deflection is within specifications and tensioner does not touch chain, replace tensioner.
5. Tensioner, that is worn beyond normal groove wear (Figure 10), must be replaced.
6. Place tensioner on flat surface. Dimension between flat surface and top (highest point) of tensioner must be 1¼″ (32mm) or higher.



a - Normal Groove Wear b - Excessive Wear Area

Figure 10. Chain Tensioner Wear

INSTALLATION

1. Position crankshaft locating key and camshaft locating key (or pin) facing as shown in Figure 9.
2. Place timing chain around sprockets and simultaneously install sprockets (with chain) on camshaft and crankshaft. Timing marks must be located as shown in Figure 9. Check timing mark location, using a straight edge.
3. Install camshaft fastening screws and torque to specifications.
4. Install chain tensioner. Liberall lubricate chain, chain tensioner and sprockets with engine oil.
5. Install front cover, stator and alternator rotor.
6. Fill cooling system and crankcase to proper levels.

MCM ENGINE COUPLER and/or FLYWHEEL

MIE Inboards, refer to "MIE Flywheel Assembly".

REMOVAL

1. Remove engine from boat.
2. Remove all attaching parts from flywheel housing and remove flywheel housing.
3. Remove coupler.
4. Remove flywheel.

INSPECTION

Engine Coupling

1. Check coupling spline for wear. Coupling wear is caused by insufficient lubrication at time of installation.
2. Inspect hub bond. Bonding, that shears or pulls loose from hub center, indicates engine/drive misalignment.

Flywheel

Inspect ring gear for worn, chipped or cracked teeth. If teeth are damaged, replace flywheel.

INSTALLATION

1. Install flywheel (aligning offset holes) on crankshaft **470R/488R Only:** Torque flywheel bolts to specifications.
2. Install engine coupler. Torque to specifications with torque wrench and Tool (91-35547).
3. Install flywheel housing and housing attaching parts.
4. Lubricate coupler splines with 2-4-C Multi-Lube and install engine in boat.

MIE FLYWHEEL ASSEMBLY

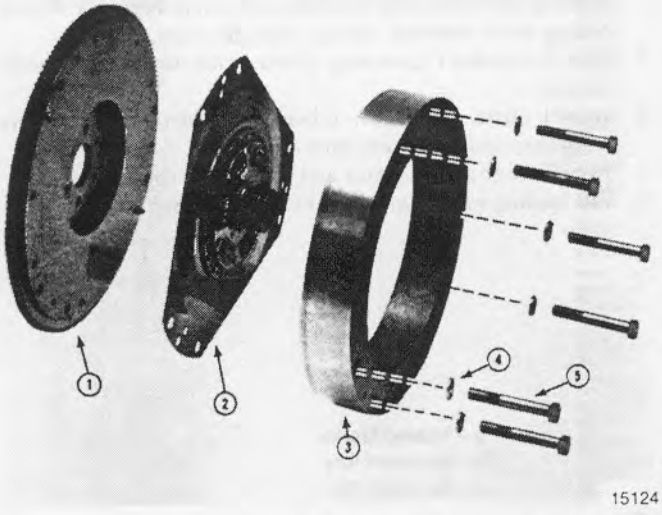
REMOVAL

1. Make the necessary disconnections, and suspend rear of engine to allow removal of transmission and flywheel housing. On some installations it may be necessary to remove engine from boat.
2. Remove flywheel housing cover plate.
3. Suspend transmission and flywheel housing assembly in such a manner that assembly will remain horizontal when removed. Remove flywheel housing attaching screws and washers and slide transmission and flywheel housing assembly backward and off engine.

   NOTE: One of the flywheel housing attaching screws is located in cavity over which electrical bracket is installed.

4. Remove drive plate and flywheel.

IMPORTANT: Some engines may have Flywheel Weight Kit (251-8478A3) installed. (Figure 1)



15124

1 - Flywheel (251-8478A2)
2 - Drive Plate (97537)
3 - Weight (97513)
4 - Lockwasher (7/16" ID; 13-32993)
5 - Screw, Weight and Drive Plate Attaching (7/16"-14x3"; 10-97546)

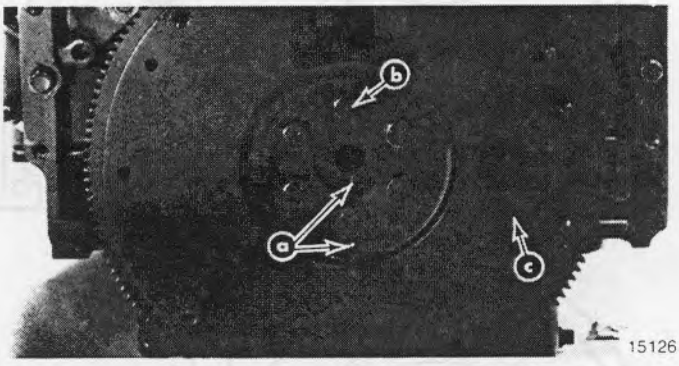
Figure 1. Flywheel Weight Kit (251-8478A3)

INSPECTION

Inspect flywheel and drive plate for damage. Replace if necessary.

INSTALLATION

1. **Engines without Weight Kit**
   a. Install flywheel and torque to specifications.
   b. Install drive plate and torque to specifications.
2. **Engines with Weight Kit**
   a. Install and torque flywheel as shown in Figure 2.

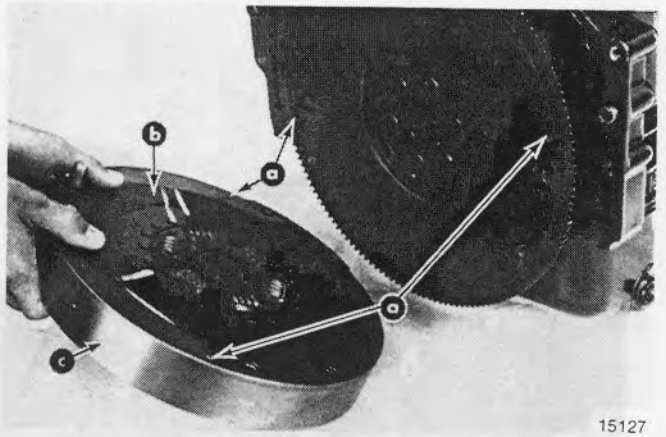


15126

a - Indexing Dot On Flywheel Aligned with Indexing Line On Crankshaft
b - Bolt and Lockwasher (Torque Bolts to Specifications With Loctite Applied to Threads)
c - Flywheel

Figure 2. Flywheel Installed

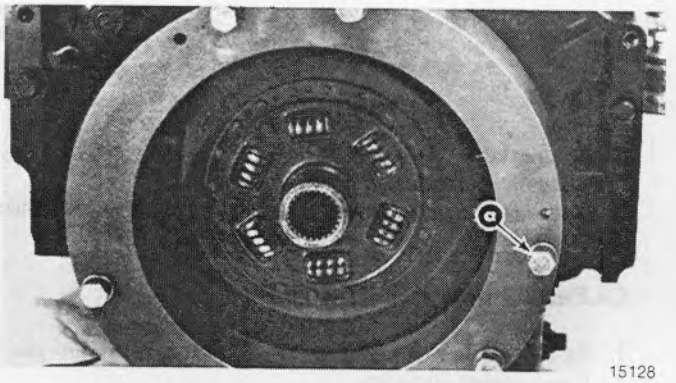
b. Apply Loctite "A" thread locking compound to threads of 6 weight and drive plate attaching screws. Align locating holes in weight with locating pins on flywheel and install drive plate and weight. (Figures 3 and 4)



15127

a - Align Hole In Weight with Locating Pin on Flywheel (2 Locations)
b - Drive Plate
c - Weight

Figure 3. Installing Weight and Drive Plate



15128

a - Torque All Bolts (with Lockwashers) to Specifications

Figure 4. Drive Plate and Weight Torque

2. Reinstall transmission and items removed. Torque flywheel housing and cover to specifications.

IMPORTANT: Check alignment as outlined in Section 2, Part I.

470/485 FLYWHEEL RING GEAR (43-97433A1) REPLACEMENT

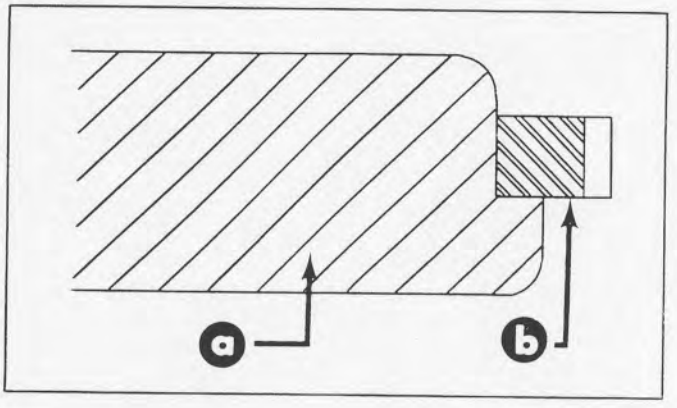
REMOVAL/REPLACEMENT

1. Remove engine from boat.
2. Remove attaching parts from flywheel housing and remove flywheel housing.
3. Remove and retain flywheel retaining nuts and washers.
4. Remove flywheel and inspect ring gear.
5. Place flywheel so that ring gear can be driven off.
6. Drive ring gear off with drift pin.
7. Place flywheel so that new ring gear can be installed onto flanged area.
8. Heat ring gear evenly all around to 300° to 400°F (149° to 205°C) (DO NOT heat to cherry red as temper of ring and teeth will be destroyed.)

⚠CAUTION

Use pliers to lift.

9. Place heated ring gear onto flywheel, making certain that it is seated properly.
10. Allow to cool and check that ring gear has seated tightly.



a - Flywheel b - Ring Gear

Figure 1. Ring Gear Replacement

INSTALLATION

1. Position flywheel onto crankshaft studs.
2. Position engine coupler (if so equipped) onto studs and install washers and locknuts.
3. Torque to specifications.
4. Install flywheel housing and attaching parts.
5. Lubricate coupler (if so equipped) with Quicksilver 2-4-C Multi-Lube.
6. Reinstall engine.

OIL PAN

REMOVAL

1. Drain crankcase oil.
2. Remove oil dipstick and dipstick tube.
3. Remove attaching bolts and washers and remove oil pan.

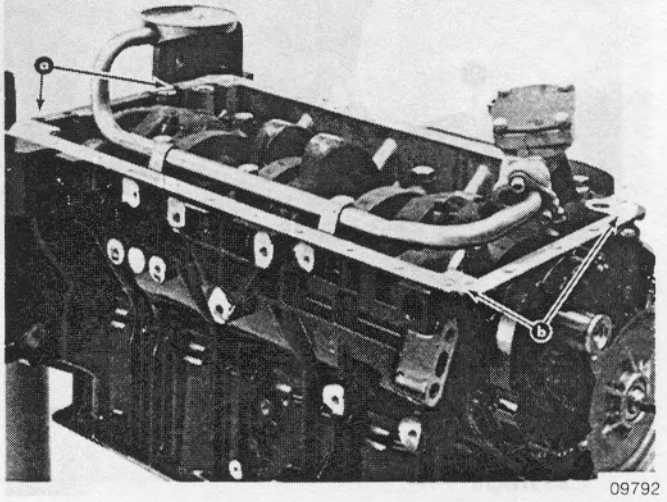
CLEANING and INSPECTION

1. Remove any dirt or metal particles from inside of pan.
2. Clean gasket surfaces.
3. Wash pan in solvent and dry thoroughly.
4. Check pan for damage.
5. Replace pan if repairs cannot be made.

INSTALLATION

IMPORTANT: Timing cover must be installed before installation of oil pan.

1. Coat gasket surfaces of block and oil pan with Perfect Seal. Apply sealer thicker in area on block where timing cover meets block and on rear main cap seals. (Figure 1)
2. Position new gasket on cylinder block gasket surface.
3. Position oil pan and install attaching bolts. Torque bolts to specifications from center outward in each direction. Retorque bolts a second time.



a - Rear Main Cap Seals b - Timing Cover Mating Surface

Figure 1. Oil Pan Installation

OIL PUMP

REMOVAL

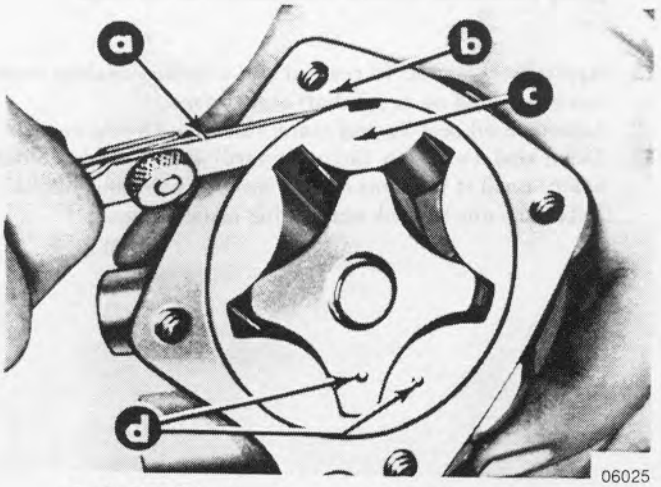
1. Remove oil pan.
2. Remove bolts from oil pump pickup tube clamps.
3. Remove oil pump attaching bolts and remove oil pump assembly.

DISASSEMBLY

1. Remove bolts and pickup tube, retaining flange and "O" ring.
2. Remove screws and lockwasher and remove cover from pump body.
3. Inner and outer rotors each have identification marks on one side. (If there aren't any marks make 2 as shown in Figure 2.) After installation, these 2 points must appear on the same side. Remove inner and outer rotor.
4. Remove welch plug, spring and valve.

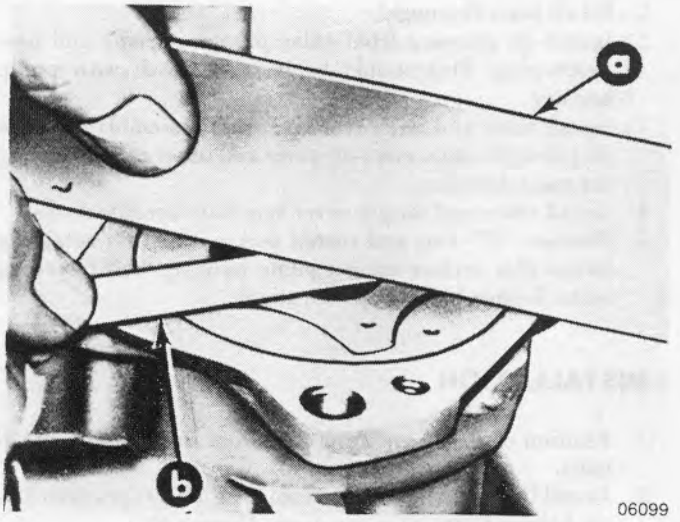
CLEANING and INSPECTION

1. Wash all parts in solvent. Clean inside of pump housing and pressure relief valve chamber. Be sure that all dirt and metal particles are removed. Dry parts thoroughly with compressed air.
2. Check inside of pump housing, outer rotor and inner rotor for damage or excessive wear.
3. Replace cover if rotor mating surface on cover is damaged.
4. Measure outer race to housing clearance, .001" to .0125" (.02mm to .3mm). (Figure 2)
5. With rotor assembly installed in pump housing, place a straight edge over rotor assembly and pump body. (Figure 3) Measure clearance (rotor end play) between straight edge and rotor, .001" to .005" (.02mm to .1mm).
6. Check drive shaft to pump housing clearance by measuring OD of shaft and ID of housing cavity, .0015" to .0025" (.0381mm to .0635mm).
7. Inspect relief valve piston for scores and free operation in bore.
8. Inspect relief valve spring for collapsed or damaged condition.



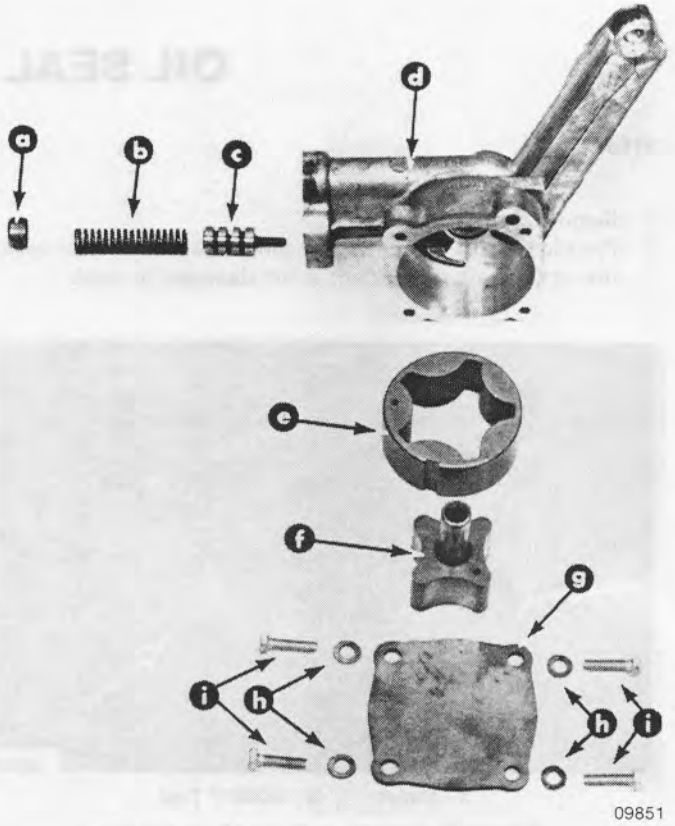
a - Feeler Gauge
b - Housing
c - Outer Race
d - Identification Marks

Figure 2. Checking Outer Rotor to Housing Clearance



a - Straight Edge
b - Feeler Gauge

Figure 3. Checking Rotor End Play



a - Welch Plug
b - Relief Valve Spring
c - Relief Valve Plunger
d - Pump Housing
e - Outer Rotor
f - Inner Rotor
g - Cover
h - Lockwasher
i - Screw

Figure 4. Oil Pump Assembly

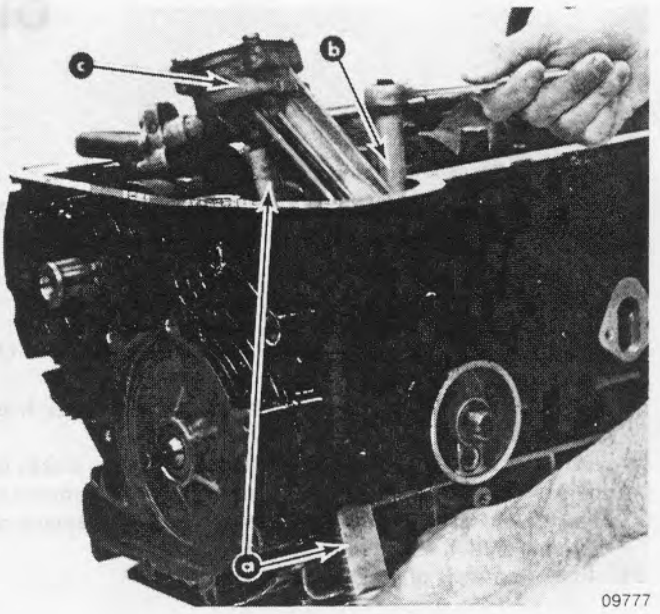
REASSEMBLY

Oil pump assembly is shown in Figure 4.

1. Oil all parts thoroughly.
2. Install oil pressure relief valve plunger, spring and new welch plug. Plug should be installed flush with pump housing.
3. Install outer and inner rotor and shaft assembly. Be sure that identification mark on outer and inner rotor is facing the same direction.
4. Install cover and torque cover screws to specifications.
5. Position "O" ring and install pickup tube, its retaining flange (flat surface against pump housing) and fastening bolts. Torque bolts to specifications.

INSTALLATION

1. Position oil pump onto cylinder block and loosely install bolts.
2. Install Oil Pump Alignment Tool (91-75691) thru distributor hole and into oil pump drive. (Figure 5)
3. Torque oil pump bolts to specifications.
4. Fasten oil pump pickup tube to cylinder block in 2 places, using clamps and screws. Torque screws to specifications.
5. Install oil pan.



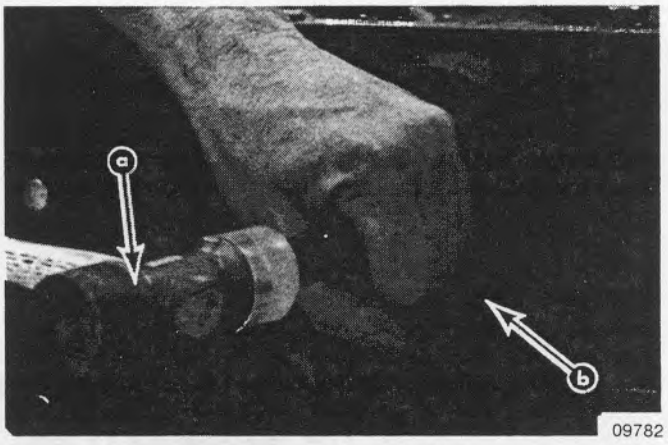
a - 91-75691 Tool
b - Torque Pump Bolts
c - Oil Pump

Figure 5. Installing Oil Pump Assembly

OIL SEAL (REAR MAIN)

REMOVAL

1. Remove flywheel.
2. Pry old oil seal from cylinder block assembly. Take care that crankshaft seal surface is not damaged by tool.



a - Mallet b - J-26817 Tool

Figure 6. Installing Rear Main Oil Seal

CLEANING and INSPECTION

1. Clean oil seal cavity in cylinder block.
2. Inspect area on crankshaft (where oil seal rides) for damage. If necessary, clean up crankshaft surface with No. 320 grit polishing cloth and engine oil. Replace crankshaft if damage is too great.
3. DO NOT reinstall used seals.

INSTALLATION

IMPORTANT: Rear main bearing cap must be properly installed before installation of oil seal.

1. Apply Perfect Seal to rear oil seal housing. Sealant must not be applied on crankshaft seal surface.
2. Lubricate oil seal lip and crank surface with engine oil.
3. Drive seal (with lip facing inward) into cylinder block cavity until it bottoms-out. (Figure 6) Use Tool J-26817. Take care not to cock seal during installation.

CAMSHAFT

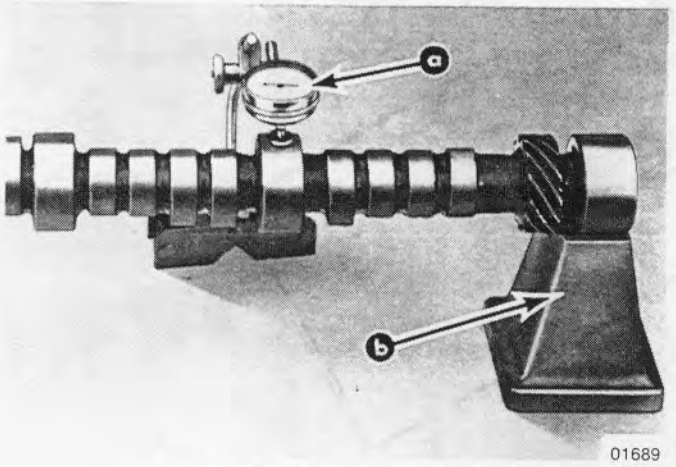
REMOVAL

1. Remove valve lifters.
2. Remove front cover.
3. Remove fuel pump.
4. Align timing gear marks, then remove timing chain and sprockets.
5. Pull camshaft out thru front of block.

IMPORTANT: Support camshaft carefully when removing to protect camshaft bearing surface.

INSPECTION

1. Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed specifications, replace camshaft.
2. Check camshaft for alignment with "V" blocks and dial indicator (Figure 1) for exact amount that camshaft is out-of-true. If out more than .002" (.051mm), replace camshaft.
3. Inspect camshaft sprocket and thrust plate for wear or damage.
4. Check all camshaft lobes with dial indicator. (Figure 1) If not within specifications, replace camshaft.



a - Dial Indicator b - "V" Blocks

Figure 1. Checking Camshaft

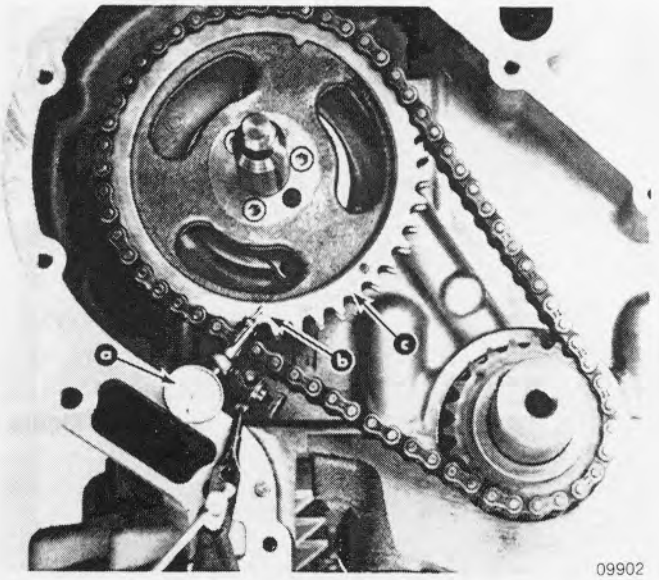
INSTALLATION

CAMSHAFT IDENTIFICATION

Model	Paint Color Near Dist. Drive Gear
MCM 470 (5195053 and below)	None
MCM 470 (5195054 and above) MIE 470 L.H. (Note 1)	None
MIE 470 R.H.	Red
MCM 485 (466-7553) (Note 1)	Green
MCM 485 (466-8330) (Note 1)	Orange
MCM 470R/488R	Blue or Pink

NOTE 1: When ordering a replacement camshaft, the 470 and 485 camshaft will be superceded by a 470R/488R camshaft. This will not affect engine performance.

1. Install camshaft in engine block, being careful not to damage camshaft bearing surface or camshaft. Install thrust plate and torque screws to specifications.
2. Install timing chain and sprockets. Torque screws to specifications.
3. With sprockets and timing chain properly installed, check camshaft end play. Use dial indicator on face of camshaft sprocket (Figure 2) and move camshaft in-and-out while recording end play. If not within specifications, replace thrust plate and/or sprocket.
4. Install fuel pump.
5. Install engine front cover.
6. Install valve lifters.



a - Dial Indicator b - Indicator Registering Point
c - Camshaft Sprocket

Figure 2. Checking Camshaft End Play

CAMSHAFT BEARINGS

Camshaft rotates directly in aluminum (cylinder block) bores. If bore surface is damaged, bore can be line bored 2.2495" to 2.2510" (57.137mm to 57.175mm) diameter and bearings can be installed. Refer to Parts Manual for bearings. If one bore surface is damaged, all bores should be enlarged and bearings installed. (Figure 3) Tool Kit T65L-6250-A should be used. Oil hole in bearing must align with oil hole in block. Follow tool manufacturer's installation instructions.

After bearings are installed, I.D. of bearings must be line bored to 2.1258"-2.1268" (53.995-54.020mm).

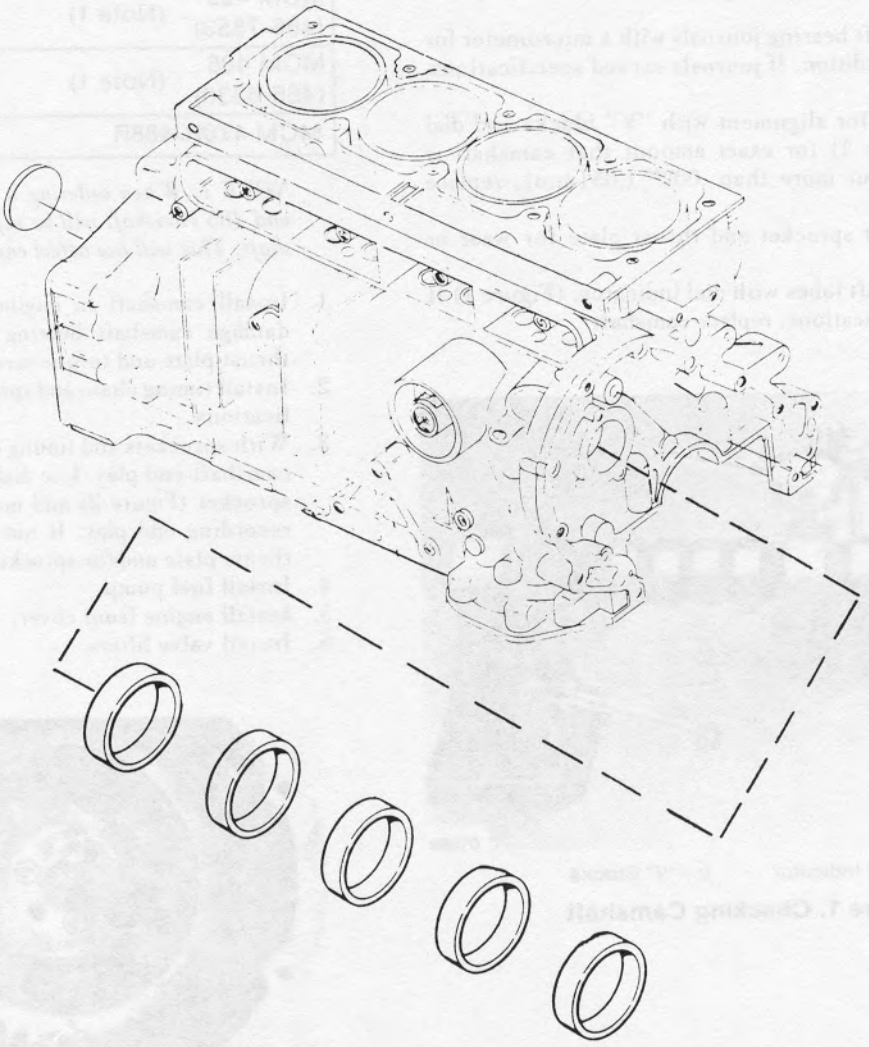


Figure 3. Camshaft Bearings

CRANKSHAFT

REMOVAL

1. Remove flywheel housing, coupler and flywheel.
2. Remove spark plugs.
3. Remove oil pan and oil pump.
4. Remove front cover and timing chain.
5. Check connecting rod caps for cylinder number identification. If necessary, mark caps.
6. Remove connecting rod caps and push pistons to top of cylinders.
7. Remove main bearing caps and rear main oil seal and lift crankshaft out of cylinder block.
8. Remove main bearings from cylinder block and main bearing caps.

CLEANING and INSPECTION

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure dimensions of all journals, oil seal area and timing sprocket location with a micrometer for out-of-round, taper or undersize (see "Specifications").
3. Check crankshaft for run-out by supporting at front and rear main bearing journals in "V" blocks and check at front and rear intermediate journals with a dial indicator.
4. Replace or recondition crankshaft if not within specifications.

INSTALLATION

1. Check bearing clearance.
2. Install bearings in cylinder block and main bearing caps, then lubricate bearing surface with engine oil. Thrust bearing is located at No. 3 position. Make sure that tab (located on back of bearings) is positioned in slot (located in cylinder block and bearing caps).
3. Apply Perfect Seal, to side seals and install in groove on each side of rear main. (Figure 4) Seal end must protrude from block side of bearing cap.
4. Apply Perfect Seal to cylinder block in area where rear main bearing cap mates with block. DO NOT apply sealer beyond centerline of bolt holes toward crankshaft. (Figure 5)

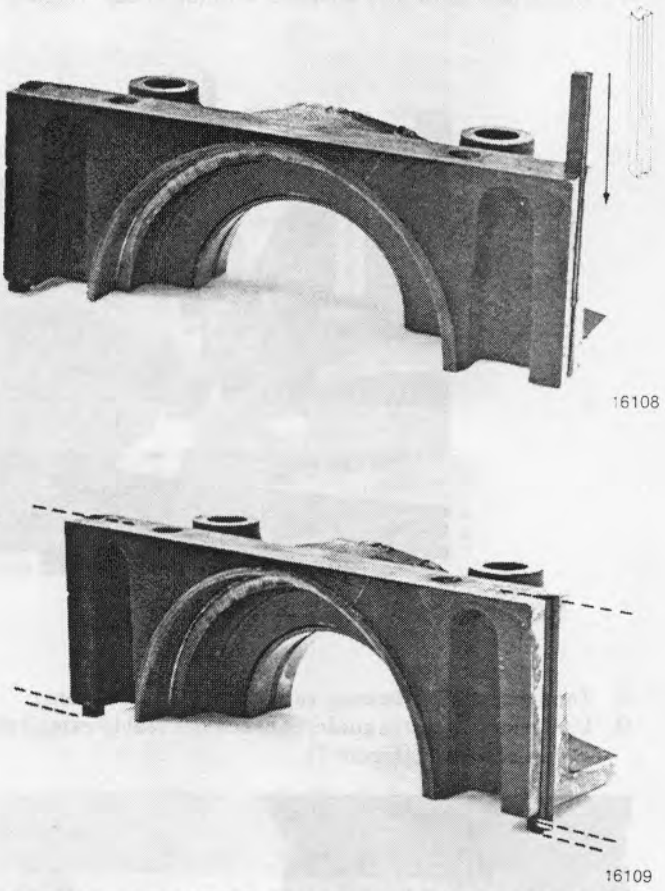


Figure 4. Rear Main Bearing Side Seal Installation

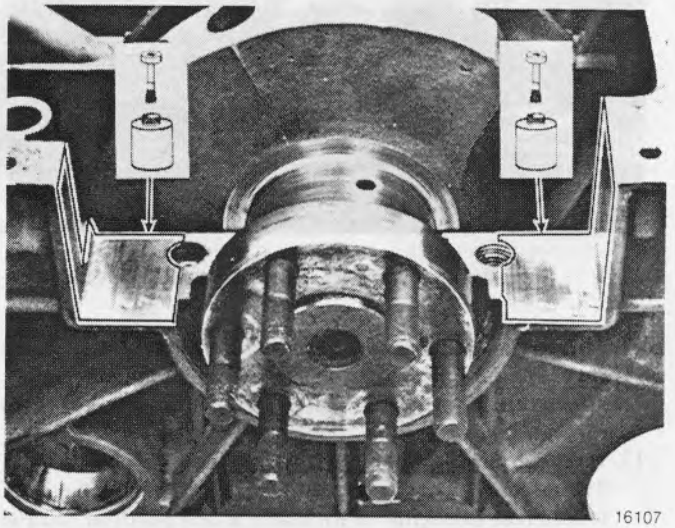


Figure 5. Applying Sealer to Cylinder Block

5. Apply Perfect Seal to outside face of side seals on rear cap to facilitate installation and install rear cap.
6. Install cap bolts, BUT DO NOT TORQUE.
7. Install pins until they are flush with top of cap. (Figure 6)

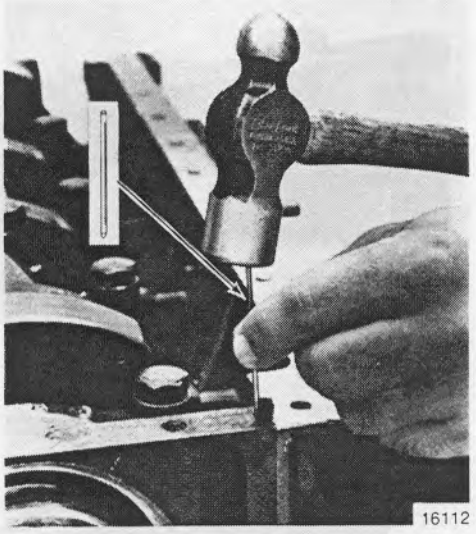


Figure 6. Installing Pins

8. Torque rear main bearing cap bolts to specifications.
9. Using feeler gauge as guide, cut each side seal to extend out of cap as shown. (Figure 7)

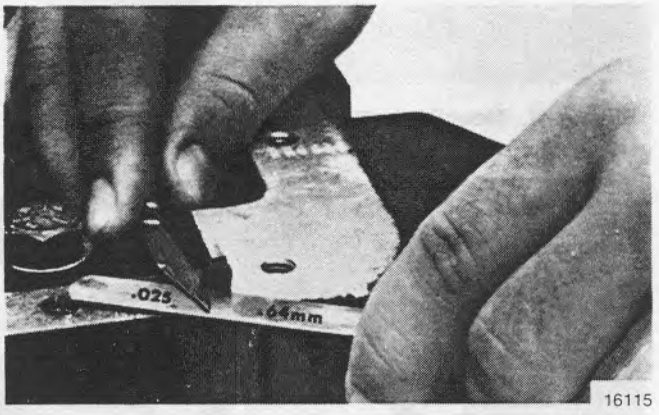
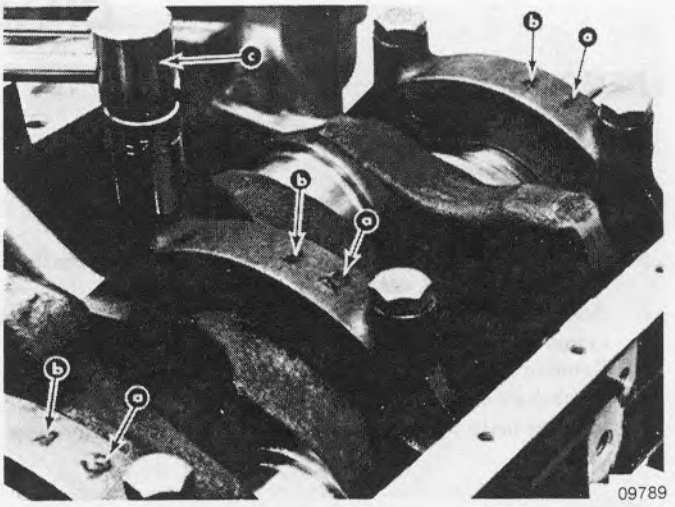


Figure 7. Cutting Rear Main Side Seals

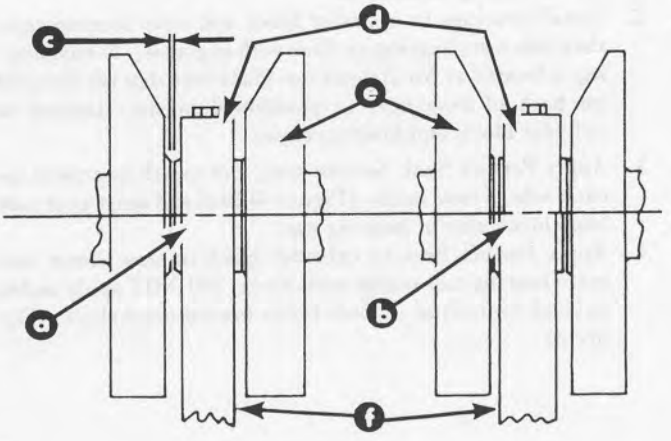
10. Install 4 other bearing caps with cast arrow pointing toward front of engine (Figure 8) and cast numbers in their respective location. Torque all bearing cap bolts (except No. 3) to specifications.
11. To prevent misalignment of thrust bearing (located at No. 3 bearing cap), pry crankshaft toward front of engine, then toward rear of engine. With crank in this position, torque bolts to specifications. Correct bearing alignment is shown in Figure 9.



a - Cast Numbers b - Cast Arrows c - Torque Wrench

Figure 8. Installing Bearing Caps

12. Check crankshaft end play with feeler gauge between thrust bearing and crankshaft.
13. Check that crankshaft turns freely with little effort. If crank does not turn freely, bearing clearances, bearing and journal diameters and crank straightness should be checked.
14. Reinstall connecting rods.
15. Install front cover, oil pump, oil pan, spark plugs, flywheel, coupler and flywheel housing.



a - Correct Alignment
b - Incorrect Alignment
c - Crankshaft End Play
d - Bearing Cap
e - Crankshaft
f - Cylinder Block

Figure 9. No. 3 Bearing Cap Installation

MAIN BEARINGS

Main bearings are precision insert type and do not utilize shim for adjustment. If clearances are found to be excessive, a new bearing (both upper and lower halves) is required. Bearings are available in standard size and undersize.

When a production standard crankshaft journal cannot be precision-fit, it then is ground undersize on all main journals. .0__" will be stamped on crankshaft front counterweight, as shown in Figure 3.

REMOVAL

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Place used bearings so that they can be installed in same location from where they were removed.

CLEANING and INSPECTION

Clean bearing inserts and caps thoroughly in solvent and dry with compressed air. DO NOT scrape gum or varnish deposits from bearing shells.

Inspect each bearing carefully. Replace bearings with scored, chipped or worn surface.

In general, lower half of bearing shows greater wear and most distress from fatigue. If lower half shows evidence of wear or damage, replace both upper and lower halves. Never replace one half without replacing other half.

CHECKING CLEARANCE and INSTALLATION

To obtain accurate results, use Plastigage (or its equivalent). The material must compress evenly between bearing and journal surfaces without damaging either surface.

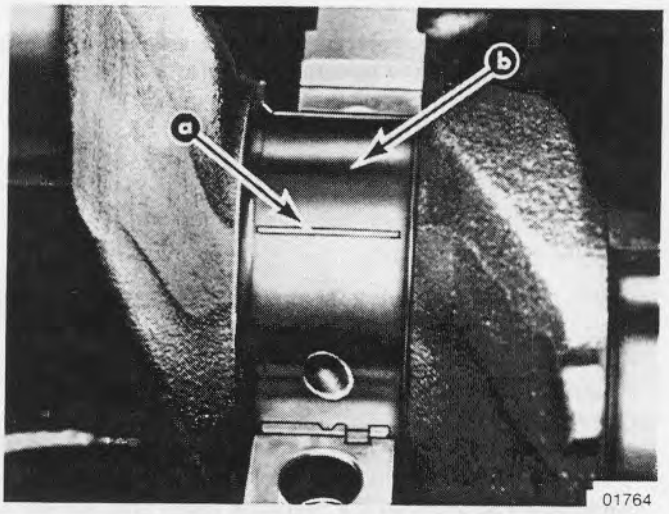
With engine upside down, crankshaft will rest on upper bearings, and total clearance can be measured between lower bearing and journal.

IMPORTANT: To assure proper seating of crankshaft, torque all bearing cap bolts as specified.

2. Place piece of gauging plastic the full width of bearing (parallel to crankshaft) on journal. (Figure 1)

⚠CAUTION

DO NOT rotate crankshaft while the gauging plastic is between bearing and journal.



a - Gauging Plastic b - Crankshaft Journal

Figure 1. Gauging Plastic on Journal

3. Install bearing cap and torque retaining bolts evenly to specifications.
4. Remove bearing cap. Flattened gauging plastic will be found adhering to either bearing shell or journal.
5. Edge of gauging plastic envelope has a graduated scale (in thousandths of an inch). Without removing gauging plastic, measure its compressed width (at widest point). (Figure 2)

IMPORTANT: Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal [.001" (.025mm) max.], be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance that indicates taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer, if flattened gauging plastic indicates more than .001" difference.

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace inserts.
7. A standard or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing. Reinstall bearing cap.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft so that no excessive drag exists.
9. Measure crankshaft end play as outlined under "Crankshaft".
10. After bearing fit is correct, remove crankshaft and oil bearing surfaces and reinstall crankshaft.

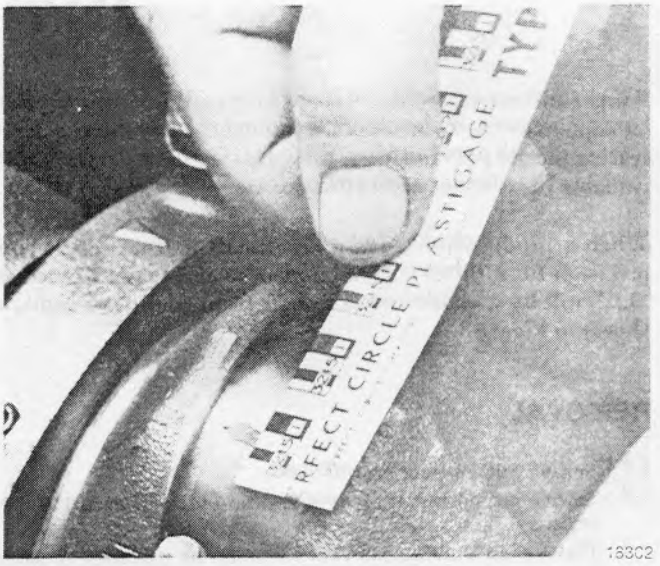


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Figure 2. Measuring Gauging Plastic

CONNECTING ROD BEARINGS

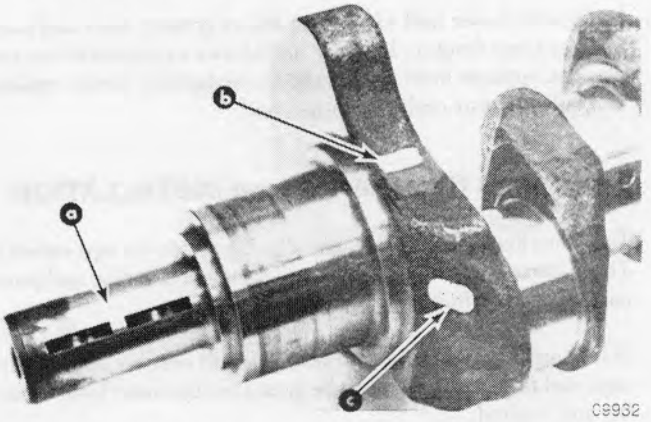
Connecting rod bearings are precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing is required. Bearings are available in standard size and undersize.

When a production standard crankshaft journal cannot be precision-fit, it then is ground undersize on all rod journals. .0__" will be stamped on crankshaft front counterweight, as shown in Figure 3.

INSPECTION and REPLACEMENT

1. Lift off connecting rod cap and bearing.
2. Inspect bearing for evidence of wear or damage.
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications and new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.

IMPORTANT: If bearing is being fitted to out-of-round crankpin, be sure to fit maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001" (0.025mm), interference between bearing and crankpin will result in rapid bearing failure.



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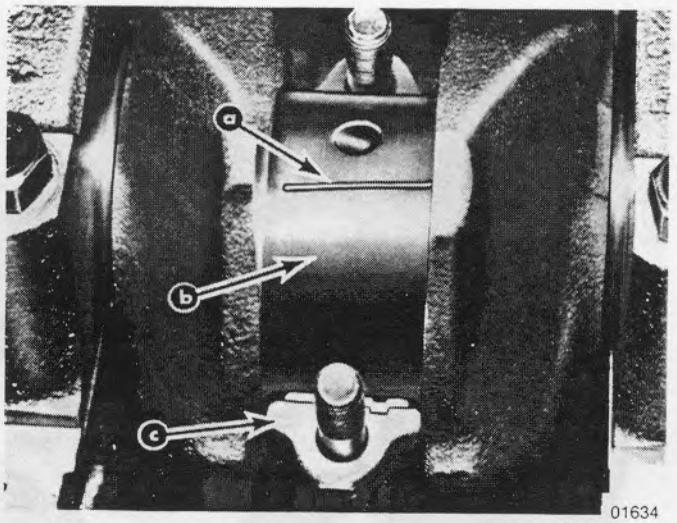
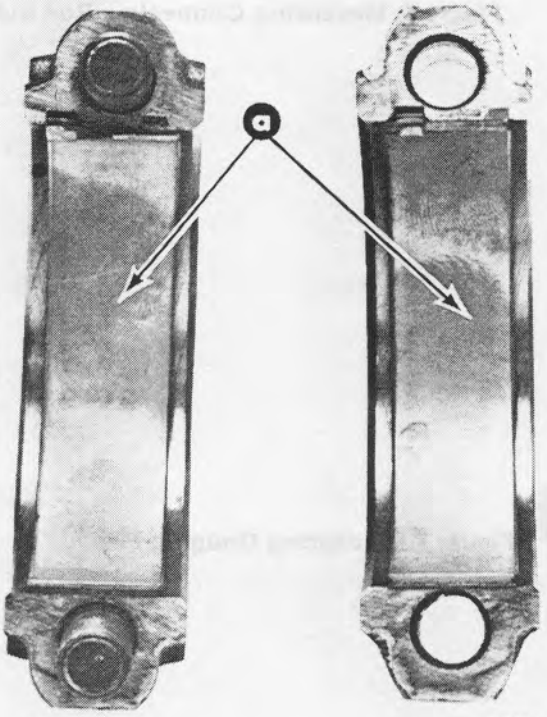
a - Front End of Crankshaft b - Main Journal Mark Location
c - Rod Journal Mark Location

Figure 3. Undersize Journal Identification



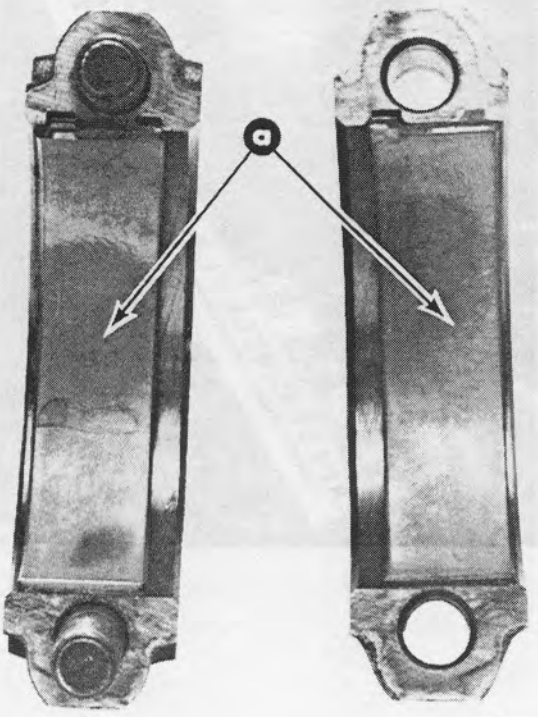
a - Gauging Plastic b - Crankpin c - Connecting Rod

Figure 4. Gauging Plastic on Crankpin



a - Centered in Connect Rod

Figure 5. Correct Bearing Installation



a - Not Centered in Connect Rod

Figure 6. Incorrect Bearing Installation

5. Measure new or used bearing clearances with Plastigage or equivalent, as follows:
   a. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft). (Figure 4)
   b. Install bearing, connecting rod and cap. Take care that tab in bearing is located correctly in rod and rod cap notches. (Figure 5) Figure 6 shows incorrect installation.
   c. Install bearing cap and torque nuts evenly to specifications.

⚠CAUTION

DO NOT turn crankshaft with gauging plastic installed.

d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at widest point. (Figure 7)

6. If clearance exceeds specifications, select a new, correct-size bearing and remeasure clearance.
7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to be sure that they have clearance.
9. Measure all connecting rod side clearances (see specifications) between connecting rod and side of crankpin. (Figure 8)

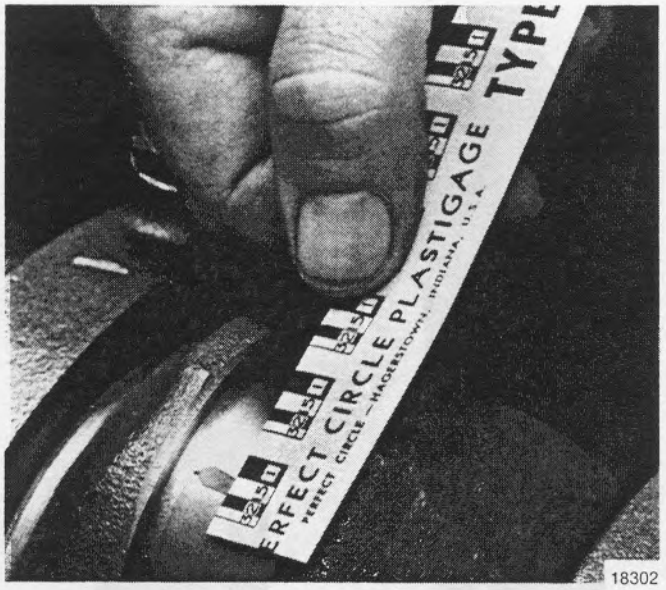
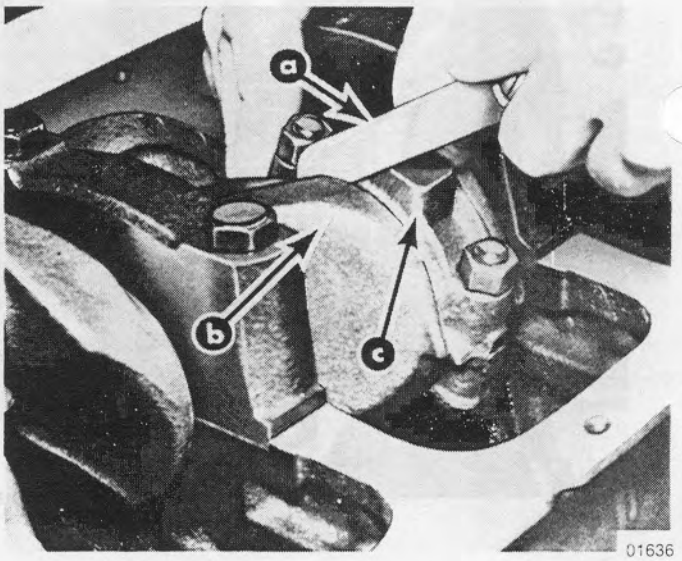


Figure 7. Measuring Gauging Plastic



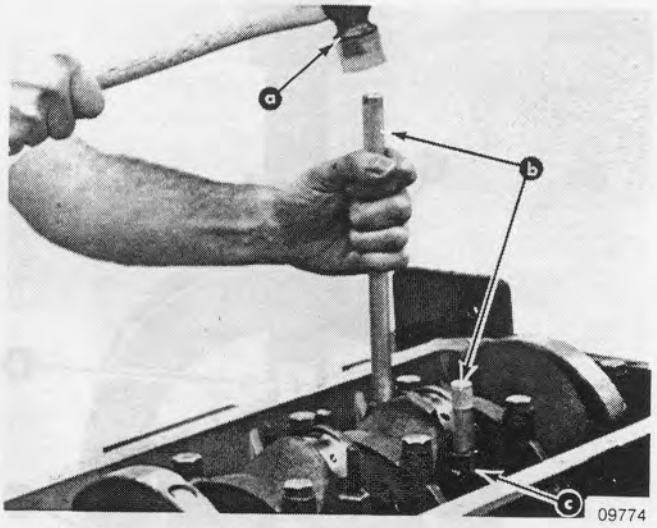
a - Feeler Gauge b - Crankshaft c - Connecting Rod

Figure 8. Measuring Connecting Rod Side Clearance

PISTON and ROD ASSEMBLY

REMOVAL

1. Remove flywheel housing and flywheel.
2. Remove cylinder head assembly.
3. Remove oil pan and oil pump.
4. Check connecting rod caps for cylinder number identification. If necessary, mark rod caps and rods.
5. Remove connecting rod caps. Install Rod Guides (J-5239) on connecting rod bolts and push pistons out top of cylinder bores. (Figure 1)

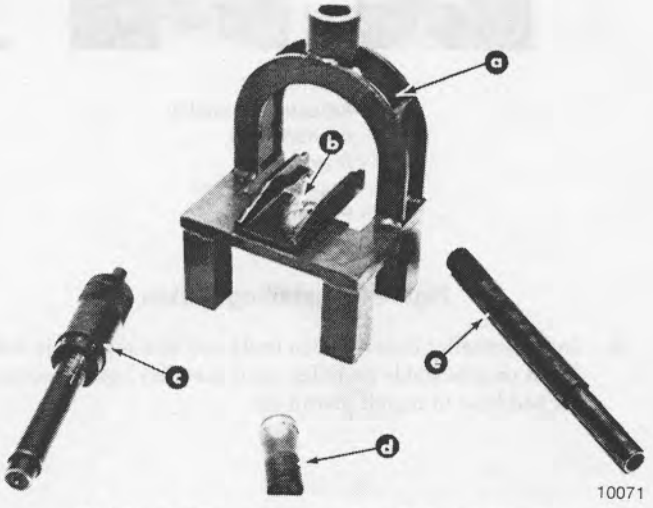


a - Mallet b - Rod Guide Tool c - Connecting Rod

Figure 1. Removing Piston and Rod Assembly

DISASSEMBLY

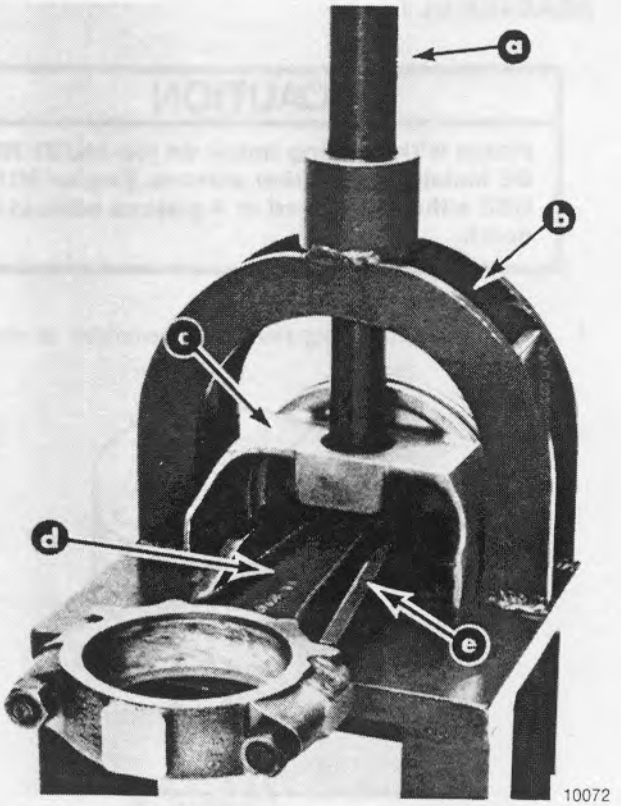
1. Use Tool Kit (J-24086-100), shown in Figure 2.



a - Arched Base
b - Rod Support
c - Adjustable Installer
d - Piston Pin Guide
e - Piston Pin Remover

Figure 2. Tool (J-24086-100) Parts Identification

2. Position connecting rod onto tool rod support with rod support inserted between connecting rod end and piston. Align piston pin with hole located in top of arched base. (Figure 3)
3. Insert pin remover thru hole (located in top of arched base) and into piston pin hole. Press on pin remover to remove piston pin. (Figure 3)



a - Piston Pin Remover
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Figure 3. Removing Piston Pin

CLEANING and INSPECTION

Connecting Rods

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for cracks. (See "Specifications".) Replace damaged rods.

Pistons

1. Clean varnish from piston skirts and pins with cleaning solvent. DO NOT WIRE BRUSH ANY PART OR PISTON.
2. Clean ring grooves with groove cleaner.
3. Inspect piston. Replace pistons which are damaged or have excessive wear.
4. Inspect piston ring grooves.
5. Measure piston and check clearance as outlined under "Piston Selection - Cylinder Block".

Piston Pins

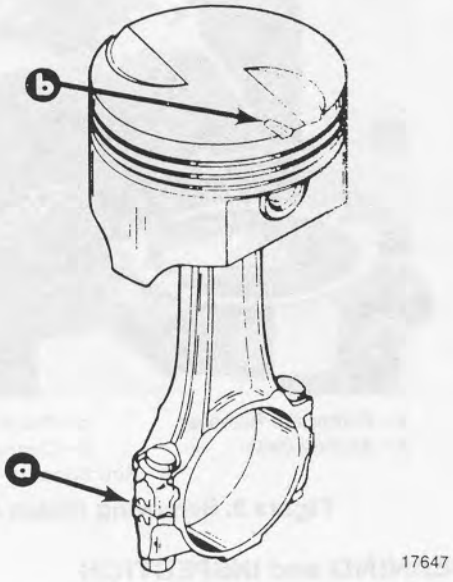
1. Piston and piston pin are matched and not serviced separately.
2. Pin bores and piston pins must be free of varnish or scuffing. Measure piston pin with micrometer and piston pin bore with bore gauge or inside micrometer. If clearance is in excess of wear limit (see "Specifications"), replace piston and pin assembly.

REASSEMBLY

⚠CAUTION

Piston with locating notch on top MUST NOT BE installed with other pistons. Engine MUST USE either 4 notched or 4 pistons without the notch.

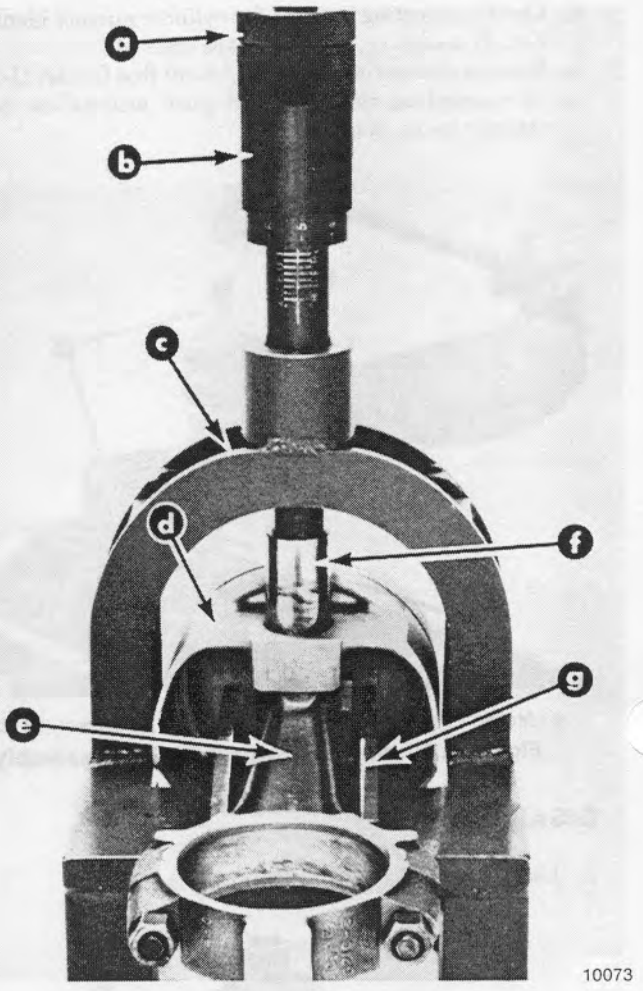
1. Piston and connecting rod are reassembled as shown in Figure 4.



a - Numbers TOWARD Camshaft
b - Pistons with Notch - Toward FRONT of Engine
Pistons without Notch - Piston Can Be Installed Either Way on Connecting Rod

Figure 4. Connecting Rod and Piston Position

2. Lubricate piston pin, piston pin hole in piston and hole in rod end with a light coat of engine oil.
3. Position rod onto rod support and piston onto rod end. Insert piston pin guide thru bottom piston pin hole and into connecting rod. Place piston pin thru top side of piston. (Figure 5)
4. Adjust adjustable installer to setting specified on chart (which came with tool) for particular piston installation. Lock adjustable installer with jam nut.



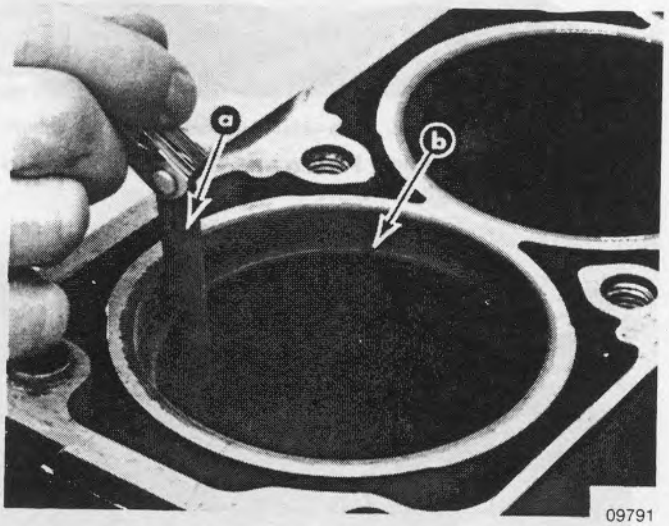
a - Jam Nut
b - Adjustable Installer
c - Arched Base
d - Piston
e - Connecting Rod
f - Piston Pin
g - Rod Support

Figure 5. Installing Piston Pin

5. Insert installer thru hole (in tool) and into piston pin hole. Press on adjustable installer until installer bottoms-out on arched base to install piston pin.

PISTON RINGS

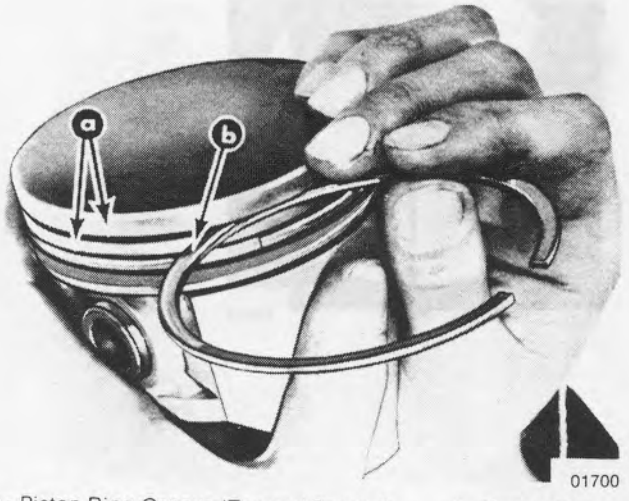
1. Select rings comparable in size to piston being used.
2. Slip compression ring in cylinder bore where ring will be used. Press ring squarely about ¼" (6mm) into cylinder bore.
3. Measure gap between ends of ring with feeler gauge. (Figure 6) If gap is below specification, remove ring and try another for fit.
4. Clean, inspect and fit piston to cylinder.



a - Feeler Gauge b - Compression Ring

Figure 6. Measuring Ring Gap

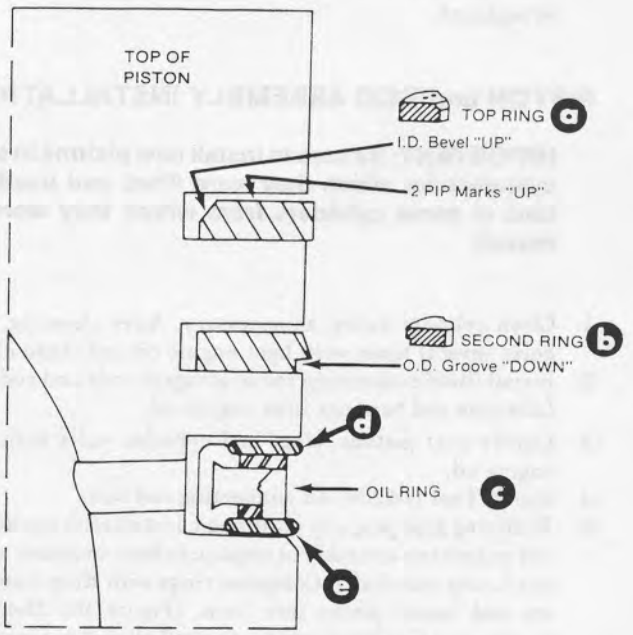
5. Insert outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around groove (Figure 7) to make sure that ring fit is free. If binding occurs at any point, determine the cause and correct.



a - Piston Ring Groove (Top and Second) b - Piston Ring

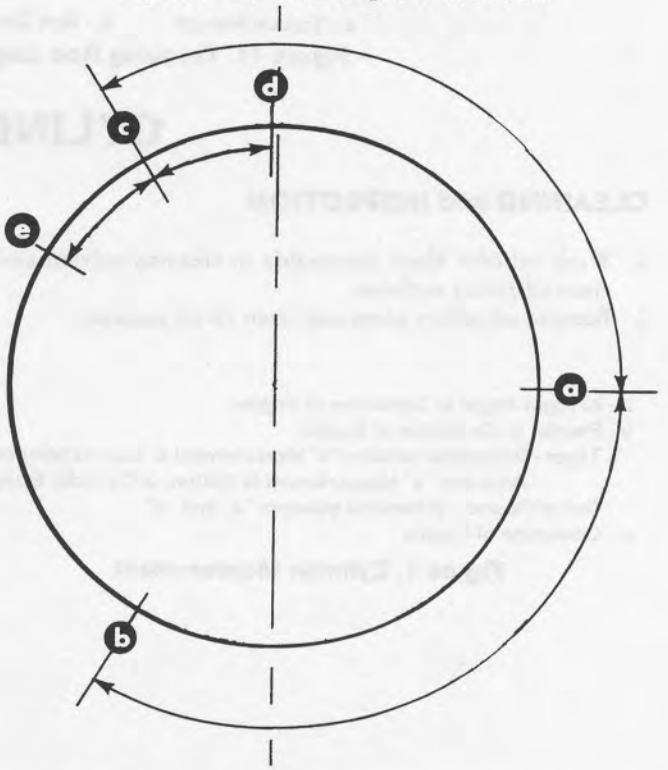
Figure 7. Checking Ring in Groove

6. Refer to Figures 8 and 9 for piston ring installation.



a - Top Ring
b - Second Ring
c - Oil Expander Ring
d - Top Oil Ring Rail
e - Lower Oil Ring Rail

Figure 8. Piston Ring Identification



a - Top Compression Ring Gap (Toward Camshaft Side of Piston)
b - Second Compression Ring Gap (120° from Top Compression Ring Gap)
c - Oil Expander Ring Gap (120° from Top Compression Ring Gap)
d - Top Oil Ring Rail Gap [Approximately 1" (25mm)]
e - Lower Oil Ring Rail Gap [Approximately 1" (25mm)]

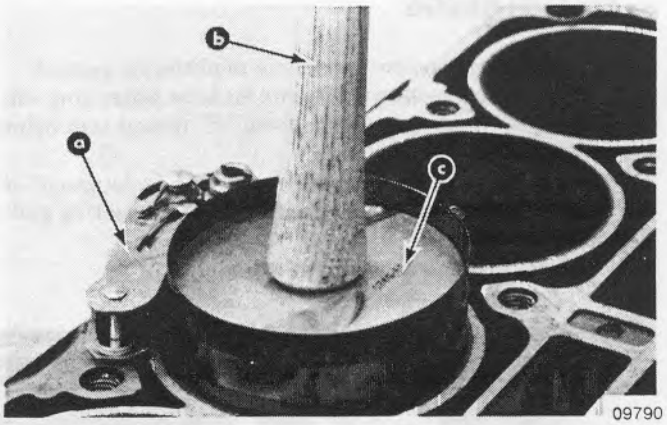
Figure 9. Piston Rings Gap Location

7. Measure clearances between compression ring and groove. (See "Specifications") If ring cannot be fitted, piston must be replaced.

PISTON and ROD ASSEMBLY INSTALLATION

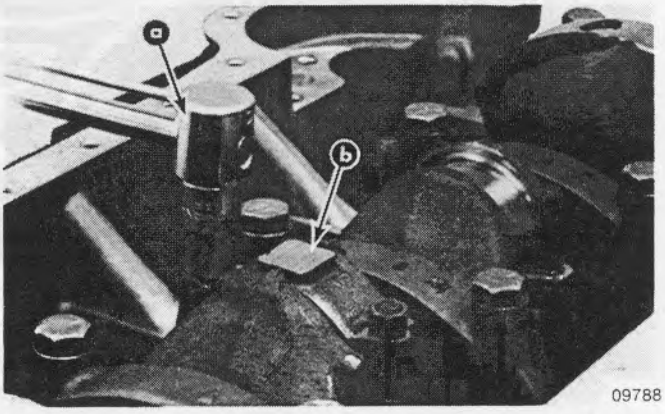
IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted and used pistons in same cylinders from which they were removed.

1. Clean cylinder bores, as necessary. After cleaning, swab bores several times with light engine oil and clean cloth.
2. Install fitted connecting rod bearings in rods and rod caps. Lubricate rod bearings with engine oil.
3. Lightly coat pistons, rings and cylinder walls with light engine oil.
4. Install Tool (J-5239) on connecting rod bolts.
5. With ring gaps properly positioned, install each connecting rod and piston assembly in respective bore (number side of rod facing camshaft). Compress rings with Ring Compressor and install piston into bore. (Figure 10) Hold ring compressor firmly against block until all piston rings have entered cylinder bore.
6. Remove guide tool from rod bolts.
7. Install bearing caps and torque nuts to specifications. (Figure 11)



a - Ring Compressor b - Hammer Handle c - Piston

Figure 10. Installing Piston and Rod Assembly into Cylinder Bore



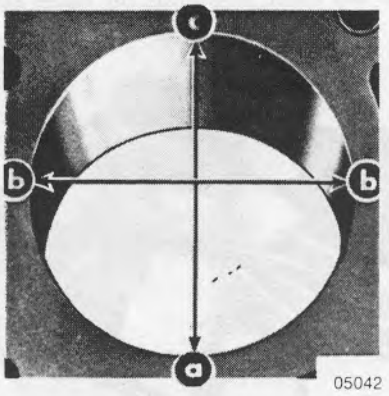
a - Torque Wrench b - Rod Cap

Figure 11. Torquing Rod Cap

CYLINDER BLOCK

CLEANING and INSPECTION

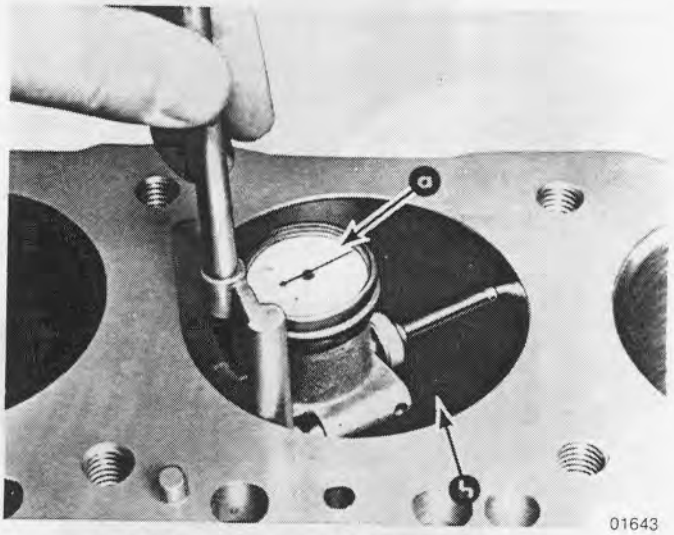
1. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
2. Remove oil gallery plugs and clean all oil passages.



a - At Right Angle to Centerline of Engine
b - Parallel to Centerline of Engine
Taper - Difference between "a" Measurement at Top of Cylinder Bore and "a" Measurement at Bottom of Cylinder Bore
Out-of-Round - Difference between "a" and "b"
c - Centerline of Engine

Figure 1. Cylinder Measurement

3. Inspect cylinder block (see "Specifications").
4. Measure the cylinder walls for taper, out-of-round or excessive ridge at top of ring travel (Figure 1) with dial indicator. (Figure 2) Set gauge so that thrust pin must be forced in about ¼" (6mm) to enter gauge in cylinder bore. Center gauge in cylinder and turn dial to "O". Carefully work gauge up-and-down cylinder to determine taper and turn gauge to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, honing and/or boring are necessary.



a - Dial Indicator b - Cylinder Bore

Figure 2. Measuring Typical Cylinder Bore

REPAIRS

Cylinder Conditioning

Condition of engine at time of repair is important. If inspection indicates that cylinder block is acceptable, except for out-of-round or tapered cylinders, condition the block by honing or boring.

If cylinders have less than .005" (0.127mm) taper or wear, condition them with a hone and fit with high limit, standard size piston. A cylinder bore of less than .005" wear or taper may not clean up entirely when fitted to a high limit piston. If such is the case, clean up bore entirely by reboring for an oversize piston. If more than .005" taper or wear, bore and hone to smallest oversize that permits complete resurfacing of all cylinders.

When pistons are fitted (honing not necessary), clean cylinder bores with detergent and hot water. After cleaning, swab cylinder bores several times with light engine oil on clean cloth, then wipe with clean, dry cloth.

Cylinder Boring

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs.
2. Measure piston to be fitted with a micrometer. Bore cylinder to same diameter as piston and hone cylinder to specifications and as outlined under "Cylinder Honing" and "Piston Selection".
3. Follow instructions furnished by manufacturer of equipment being used.

Cylinder Honing

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up-and-down to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 30° to cylinder bore. Finish marks should be clean but not sharp and free from imbedded particles and torn or folded metal.

⚠CAUTION

Handle pistons with care and DO NOT attempt to force them thru cylinder until cylinder has been honed to correct size, as this type piston can be distorted thru careless handling.

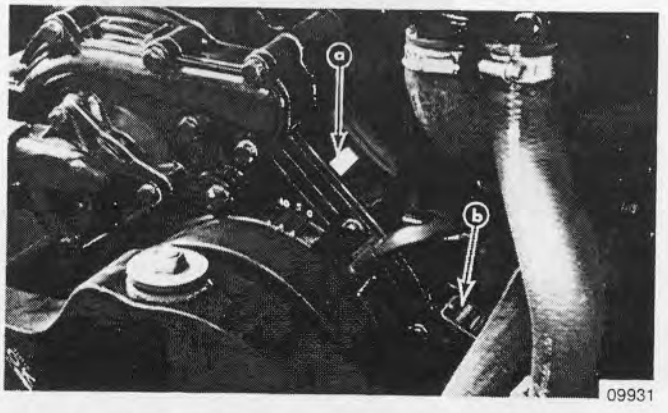
4. Permanently mark piston for cylinder to which it has been fitted and proceed to hone cylinders and fit remaining pistons.
5. Thoroughly clean cylinder bores with hot water and detergent. Rinse thoroughly with hot water.
6. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean, dry cloth. DO NOT clean cylinder with kerosene or gasoline.

PISTON SELECTION

⚠CAUTION

Piston with locating notch on top (Figure 7), MUST NOT BE installed with other pistons. (Figure 5 or 6) Engine MUST USE either 4 notched or 4 pistons without the notch.

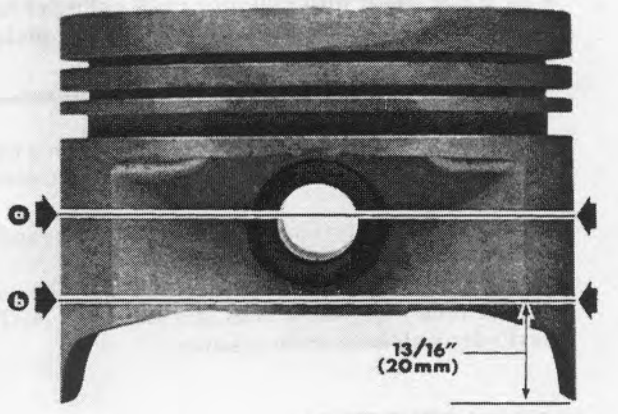
When a production standard piston cannot be precision-fit, cylinder bore is enlarged and oversize pistons are installed in all cylinders. .0__" is stamped on cylinder block in area shown in Figure 3.



a - Identification Mark Location b - Serial Plate

Figure 3. Oversize Cylinder Bore Identification Mark Location

1. Check USED piston to cylinder bore clearance as follows:
   a. Measure "Cylinder Bore Diameter" with a telescope gauge.
   b. Measure "Piston Diameter" at location shown in Figure 4.
   c. Subtract piston diameter from cylinder bore diameter to determine "Piston to Bore Clearance".
   d. Determine if piston to bore clearance is in acceptable range. (See Figures 5, 6 or 7)
2. If used piston is not acceptable, check oversize pistons available. Refer to Parts Manual.
3. If cylinder bore must be reconditioned, measure new piston diameter, then hone cylinder bore to correct clearance.
4. Mark piston to identify cylinder for which it was fitted.



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a - Figure 5 or 6 b - Figure 7

Figure 4. Piston Diameter Location

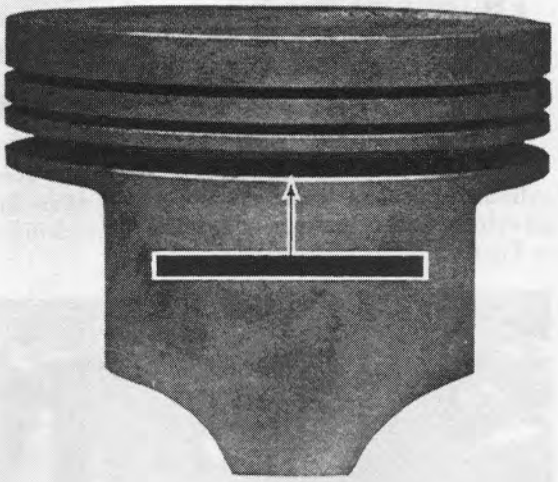

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Figure 5. .002"-.0037" (.05-.09mm)

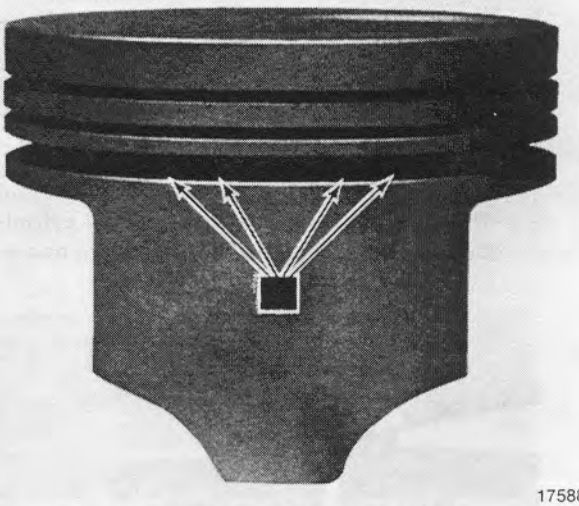

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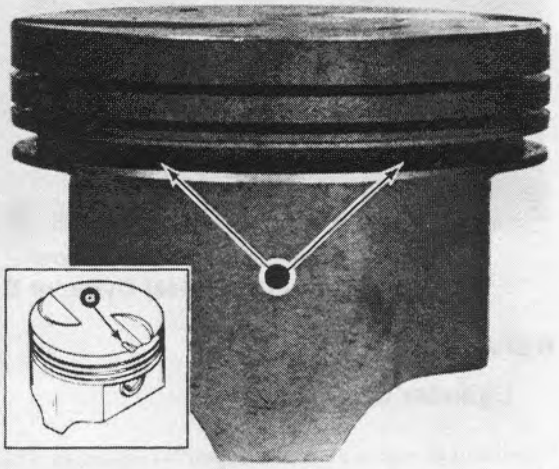
Figure 6. .004"-.0057" (.1-.15mm)



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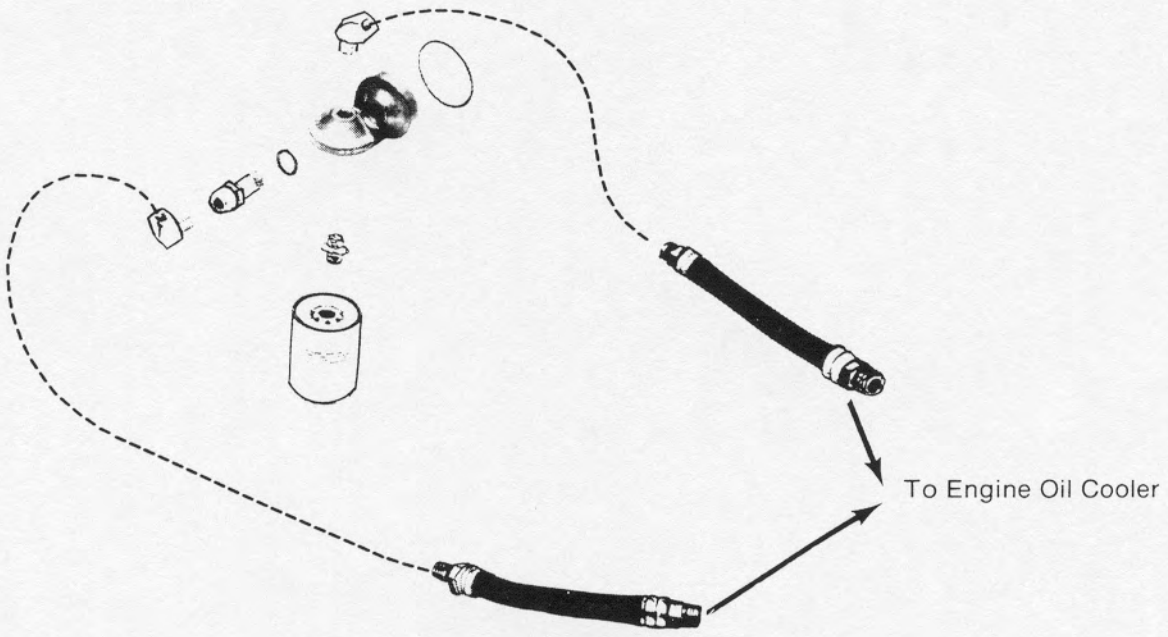
a - Notch

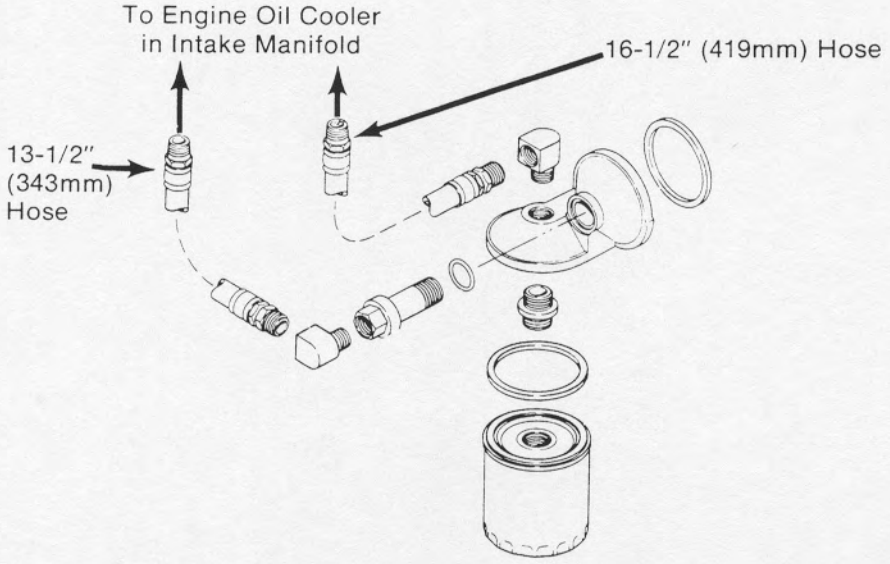
Figure 7. .001"-.0027" (.03-.06mm)

OIL FILTER ADAPTORS

MCM 485

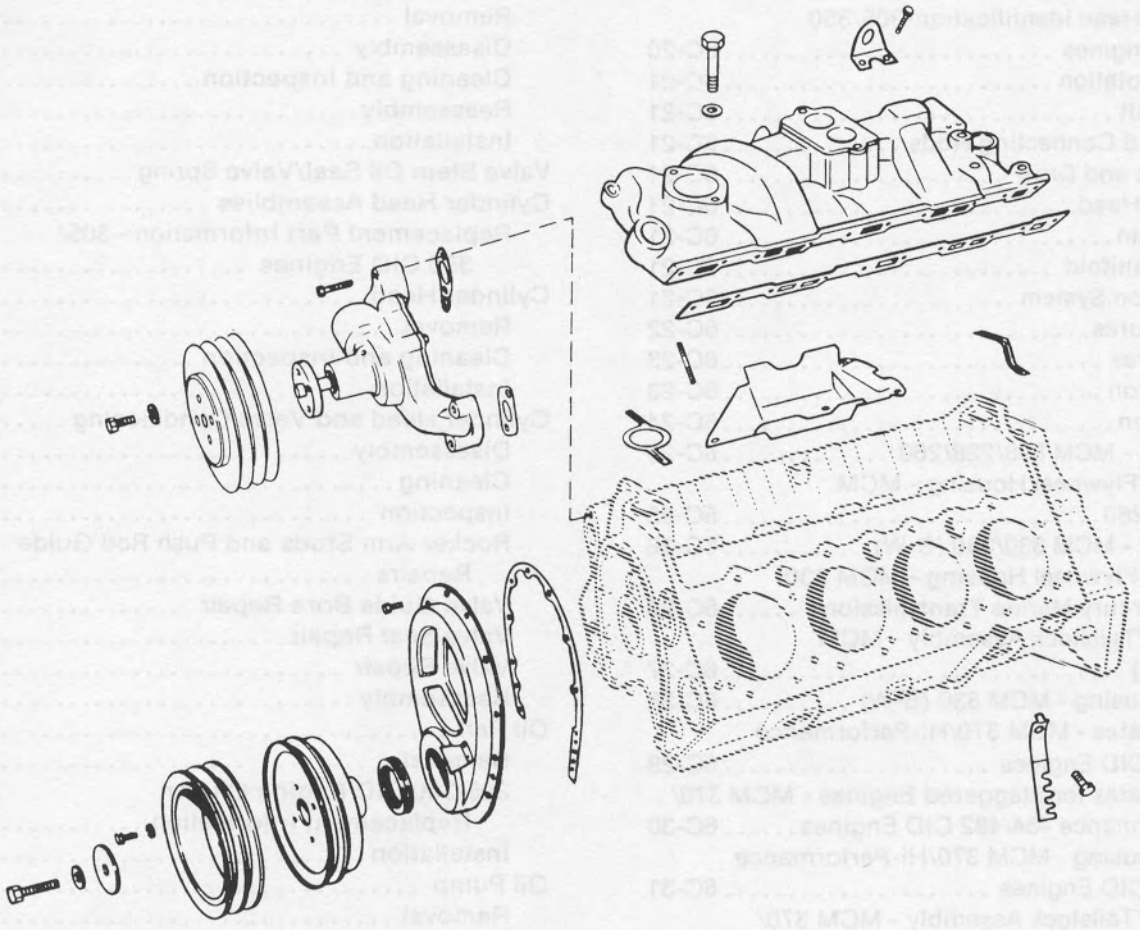


MCM 488R



SECTION 6 - ENGINE

PART C - V-8 GM



MERCURY MARINE
A BRUNSWICK COMPANY

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STERN DRIVES & INBOARDS

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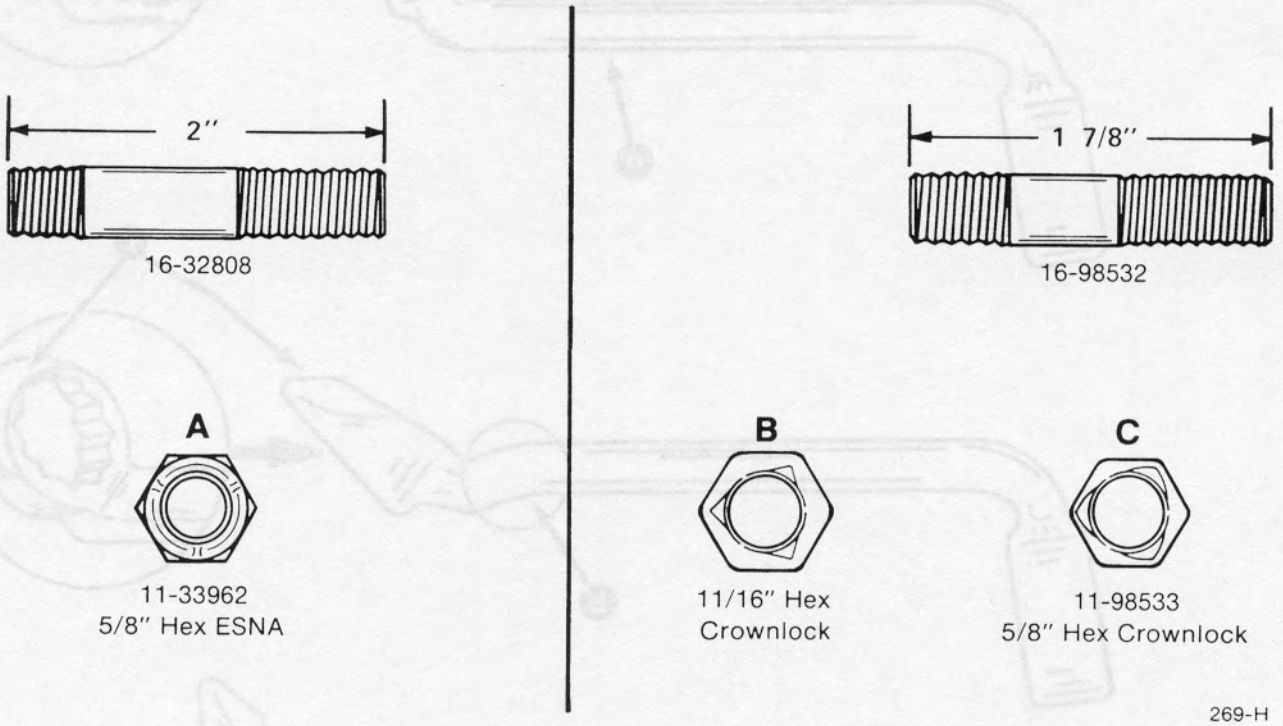
TORQUE SPECIFICATIONS
305 and 350 CID Engines

Fastener Location	305 CID		350 CID	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace to Alternator		192 (28)		192 (28)
Alternator Brace to Block	30 (41)		30 (41)	
Alternator to Mounting Bracket	35 (48)		35 (48)	
Alternator Mounting Bracket	30 (41)		30 (41)	
Camshaft Sprocket/Gear	20 (27)		20 (27)	
Carburetor		132 (15)		132 (15)
Connecting Rod Cap	45 (61)		45 (61)	
Coupler/Flywheel (MCM)	See Figure 1			
Crankshaft Damper	60 (81)		60 (81)	
Crankshaft Pulley	35 (48)		35 (48)	
Cylinder Head	65 (88)		65 (88)	
Distributor Hold Down	25 (34)		25 (34)	
Exhaust Manifold	20 (27)		20 (27)	
Flywheel (MIE)	60 (81)		60 (81)	
Flywheel Drive Plate (MIE)	35 (48)		35 (48)	
Flywheel Housing to Block	30 (41)		30 (41)	
Flywheel Housing Cover		80 (9)		80 (9)
Front Mount Bracket	30 (41)		30 (41)	
Fuel Pump	30 (41)		30 (41)	
Intake Manifold	30 (41)		30 (41)	
Main Bearing Cap	80 (109)		80 (109)	
Oil Filter Bypass Valve		80 (9)		80 (9)
Oil Pan Plug	20 (27)		20 (27)	
Oil Pan Screw (1/4"-20)		80 (9)		80 (9)
Oil Pan Screw (5/16"-18)		165 (19)		165 (19)
Oil Pump	65 (88)		65 (88)	
Oil Pump Cover		80 (9)		80 (9)
Power Steering Pump Brace to Block	30 (41)		30 (41)	

Fastener Location	305 CID		350 CID	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Power Steering Pump Bracket	30 (41)		30 (41)	
Rear Mount (MCM)	40 (54)		40 (54)	
Rear Mount (MIE)	50 (68)		50 (68)	
Remote Oil (1/2"-13)	25 (34)		25 (34)	
Filter Adaptor (5/16"-18)	20 (27)		20 (27)	
Rocker Arm Cover		50 (5.5)		50 (5.5)
Seawater Pump Brace	30 (41)		30 (41)	
Seawater Pump Bracket	30 (41)		30 (41)	
Spark Plugs		180 (20)		180 (20)
Starter Motor	50 (68)		50 (68)	
Thermostat Housing	30 (41)		30 (41)	
Timing Chain or Gear Cover		80 (9)		80 (9)
Transmission to Housing	50 (68)		50 (68)	
Water Circulating Pump	30 (41)		30 (41)	
Water Temp. Sender	20 (27)		20 (27)	

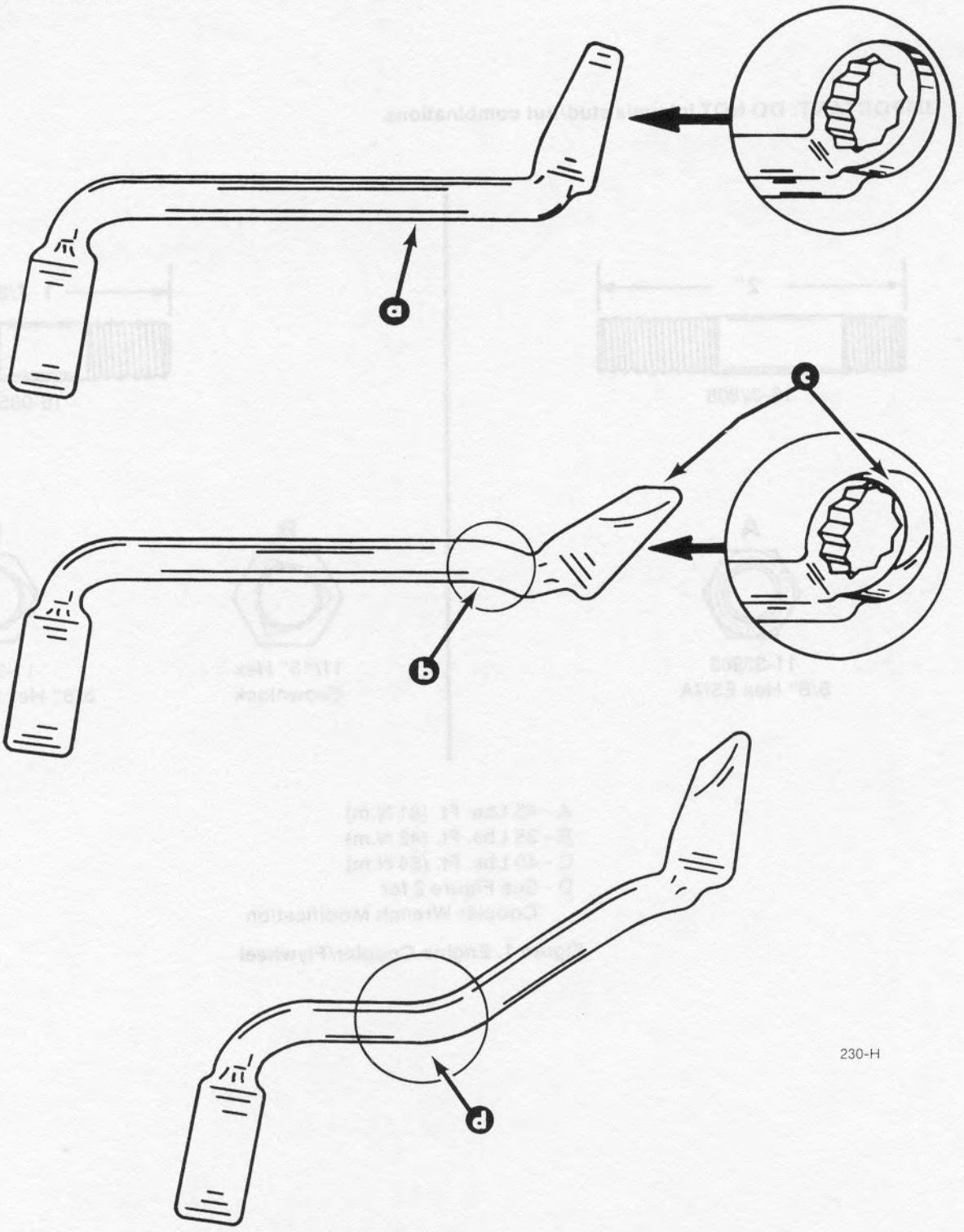
IMPORTANT: DO NOT intermix stud/nut combinations.



A - 45 Lbs. Ft. (61 N.m)
B - 35 Lbs. Ft. (42 N.m)
C - 40 Lbs. Ft. (54 N.m)
D - See Figure 2 for
Coupler Wrench Modification

Figure 1. Engine Coupler/Flywheel

Engine Coupler Wrench, 91-35547, may not work on the later couplers. Modify wrench as shown in Figure 2, so it will work on both earlier and later style couplings.



a - Original 91-35547 Wrench
b - Heat and Bend as Shown
c - Grind Area Shown Slightly
d - Heat and Bend as Shown (This is what wrench should look like when it's done)

Figure 2. Modifying Engine Coupler Wrench

TORQUE SPECIFICATIONS
454/482 CID Engines

Fastener Location	454 CID (Standard)		454/482 CID Hi-Performance	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace to Alternator		192 (28)		192 (28)
Alternator Brace to Block	30 (41)		30 (41)	
Alternator to Mounting Bracket	35 (48)		35 (48)	
Alternator Mounting Bracket	30 (41)		30 (41)	
Camshaft Sprocket	25 (34)		25 (34)	
Camshaft Thrust Plate Screws (R.H. Only)		96 (11)		
Carburetor		132 (15)		132 (15)
Connecting Rod Cap	50 (68)			
Connecting Rod Cap (370/400/440/475)			65 (88)	
Connecting Rod Cap (460)			90 (122)	
Crankshaft Damper	85 (115)		85 (115)	
Crankshaft Pulley	35 (48)		35 (48)	
Cylinder Head (Except 475)	80 (109)		80 (109)	
Cylinder Head (475)			85 (115)	
Distributor Hold Down	25 (34)		25 (34)	
Exhaust Manifold	20 (27)			
Exhaust Manifold (Bolts)			35 (48)	
Exhaust Manifold (Nuts)			25 (34)	
Flywheel	65 (88)		65 (88)	
Flywheel Drive Plate	35 (48)		35 (48)	
Flywheel Housing to Block	30 (41)		30 (41)	
Flywheel Housing Cover		80 (9)		80 (9)
Front Mount Bracket	30 (41)		30 (41)	
Fuel Pump	20 (27)		20 (27)	
Intake Manifold	30 (41)		30 (41)	
Main Bearing Cap	110 (149)		110 (149)	
Oil Filter Bypass Valve		80 (9)		80 (9)

Fastener Location	454 CID (Standard)		454/482 CID Hi-Performance	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Oil Pan Plug	20 (27)		20 (27)	
Oil Pan Screw (1/4"-20)		80 (9)		80 (9)
Oil Pan Screw (5/16"-18)		165 (19)		165 (19)
Oil Pump	65 (88)		65 (88)	
Oil Pump Cover		80 (9)		80 (9)
Power Steering Pump Brace to Block	30 (41)		30 (41)	
Power Steering Pump Bracket	30 (41)		30 (41)	
Rear Mount Compression Nuts (Mercury Marine Transmission)		70 (8)		
Rear Mount Bolts (MCM)	40 (54)		100 (136)	
Rear Mounts (MIE)	50 (68)		50 (68)	
Remote Oil (1/2"-13)	25 (34)		25 (34)	
Filter Adaptor (5/16"-18)	20 (27)		20 (27)	
Rocker Arm Cover		50 (5.5)		50 (5.5)
Rocker Arm Studs	50 (68)		70 (95)	
Seawater Pump Brace	30 (41)		30 (41)	
Seawater Pump Bracket	30 (41)		30 (41)	
Spark Plugs		180 (20)		180 (20)
Starter Motor	50 (68)		50 (68)	
Thermostat Housing	30 (41)		30 (41)	
Timing Chain or Gear Cover		80 (9)		80 (9)
Transmission to Housing	50 (68)		50 (68)	
Transmission to Block (Mercury Marine Transmission)	50 (68)			
Water Circulating Pump	30 (41)		30 (41)	
Water Temp. Sender	20 (27)		20 (27)	

TOOLS/LUBRICANTS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-24697	Piston Ring Expanders
91-35547	Engine Coupler Wrench
91-66273	Rocker Stoppers

KENT-MOORE SPECIAL TOOLS Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
J5892	Valve Spring Compressor
J8062	Valve Spring Compressor
J8056	Valve Spring Tester
J8101	Valve Guide Cleaner
J5830-2	Valve Guide Reamer
J7049-5	Valve Guide Reamer Set
J5802-01	Rocker Arm Stud Remover
J6880	Rocker Arm Stud Installer
J5715	Rocker Arm Stud Hole Reamer (.003" O.S.)
J6036	Rocker Arm Stud Hole Reamer (.013" O.S.)
J8089	Carbon Remover Brush
J24086-100	Piston Pin Tool
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J5289	Connecting Rod Bolt Guide Set (3/8" Bolts)
J6305-1	Connecting Rod Bolt Guide Set (11/32" Bolts)
J8369	Oil Pump Suction Pipe Installer
J6098-01	Camshaft Bearing Remover and Installer Tool
J23523-03	Harmonic Balancer Removal and Installer Tool
J22102	Crankcase Front Cover Seal Installer
J23042	Crankcase Front Cover Seal Installer
J1619	Crankshaft Gear and Sprocket Puller
J8105	Crankshaft Gear Puller
J5590	Crankshaft Gear and Sprocket Installer
J21058-20	Crankshaft Gear Installer

LUBRICANTS/SEALANTS	
92-32609-1	Quicksilver Loctite
92-34227	Quicksilver Perfect Seal
92-42649A1	Quicksilver Needle Bearing Assembly Lubricant
92-91601-1	Quicksilver RTV Sealer

ENGINE SPECIFICATIONS

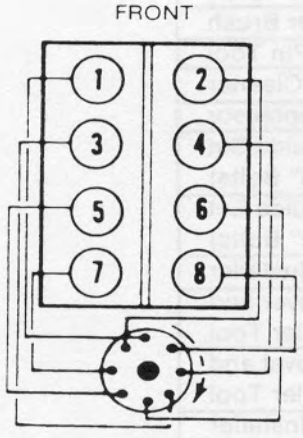
UNIT OF MEASUREMENT
in. (mm)

NOTICE TO USERS OF THIS MANUAL

We have not attempted to give the complete repair procedures for Hi-Performance 400 Cyclone, 440 Cyclone, 460 Cyclone or 475 Turbo Engines. While the repair procedures for the Hi-Performance 454 CID Engine may be used in repairing "Cyclone" and "Turbo" engines, it is recommended that only mechanics familiar with hi-performance engines attempt the repairs. We have included the engine specifications for "Cyclone" and "Turbo" engines. Refer to "HI-PERFORMANCE ENGINE SPECIFICATIONS".

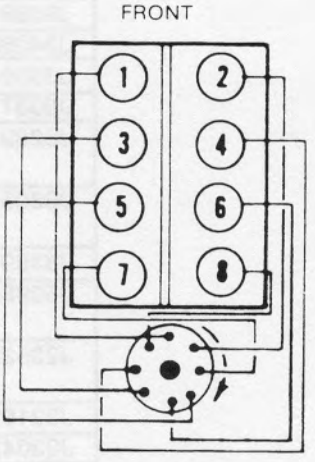
Model	898, 228, 230	255, 260	330, 330TR/TRS, 340 (Note 1)	370-TRS 400-TRS (Note 2)
Displacement	305 CID	350 CID	454 CID (Standard)	454 CID (Hi-Performance)

NOTE 1: In this manual, engine used with these models will be referred to as a "standard 454 CID engine".
NOTE 2: In this manual, engine used with these models will be referred to as a "hi-performance 454 CID engine".



Firing Order
1-8-4-3-6-5-7-2

Figure 1. Left-Hand (Standard) Rotation Engine



Firing Order
1-2-7-5-6-3-4-8

Figure 2. Right-Hand (Opposite) Rotation Engine

Engine	305 CID	350 CID	454 CID (Standard)	454 CID (Hi-Performance)

Cylinder Bore:

Diameter			3.7350 - 3.7385 (94.8690 - 94.9579)	3.9995 - 4.0025 (101.5873 - 101.6635)	4.2495 - 4.2525 (107.9373 - 108.0135)	4.2451 - 4.2525 (107.8255 - 108.0135)
Out of Round	Production		.001 (.025) Max.			
	Service		.002 (.05) Max.			
Taper	Production	Thrust Side	.0005 (.0127) Max.			
		Relief Side	.001 (.025) Max.			
	Service		.001 (.025) Max.			

Piston:

Clearance	Production	.0007 - .0017 (0.178 - .0432)	.0014 - .0024 (.0356 - .0610)	.0045 - .0065 (.1143 - .1651)
	Service	.0027 (.07) Max.	.0035 (.09) Max.	.0075 (.15) Max.

Piston Ring:

Compression	Groove Side Clearance	Production	Top	.0012 - .0032 (.0305 - .0813)	.0017 - .0032 (.04 - .08)
			2nd	.0012 - .0032 (.0305 - .0813)	.0017 - .0032 (.04 - .08)
		Service		Hi Limit Production + .001 (.025)	
	Gap	Production	Top	.010 - .020 (.25 - .5)	
			2nd	.010 - .025 (.25 - .6)	.010 - .020 (.25 - .5)
		Service		Hi Limit Production + .010 (.25)	
Oil	Groove Side Clearance	Production		.002 - .007 (.05 - .15)	.005 - .0065 (.15)
		Service		Hi Limit Production + .001 (.02)	
	Gap	Production		.015 - .055 (.35 - 1.35)	.020 - .035 (.5 - .85)
		Service		Hi Limit Production + .010 (.25)	

Piston Pin:

Diameter		.9270 - .9273 (23.5458 - 23.5534)	.9895 - .9898 (25.1333 - 25.1409)
Clearance	Production	.00025 - .00035 (.00635 - .00889)	
	Service	.001 (.02) Max.	
Fit in Rod		.0008 - .0016 (.0203 - .0406) Interference	

Engine			305 CID	350 CID	454 CID (Standard)	454 CID (Hi-Performance)
Crankshaft:						
Main Journal	Diameter	No. 1	2.4484 - 2.4493 (62.1894 - 62.2122)		2.7485 - 2.7494 (69.8119 - 69.8348)	
		No. 2, 3, 4	2.4481 - 2.4490 (62.1817 - 62.2046)		2.7481 - 2.7490 (69.8017 - 69.8246)	
		No. 5	2.4479 - 2.4488 (62.1767 - 62.1995)		2.7478 - 2.7488 (69.7941 - 69.8195)	
	Taper	Production	.0002 (.0051) Max.			
		Service	.001 (.025) Max.			
	Out of Round	Production	.0002 (.0051) Max.			
		Service	.001 (.025) Max.			
Main Bearing Clearance	Production	No. 1	.0008 - .0020 (.0203 - .0508)		.0013 - .0025 (.0330 - .0635)	
		No. 2, 3, 4	.0011 - .0023 (.0279 - .0584)			
		No. 5	.0017 - .0032 (.0432 - .0813)		.0024 - .0040 (.0610 - .1016)	
	Service	No. 1	.001 - .0015 (.03)			
		No. 2, 3, 4	.001 - .0025 (.03 - .06)			
		No. 5	.0025 - .0035 (.07 - .08)			
Crankshaft End Play			.002 - .006 (.05 - .15)		.006 - .010 (.15 - .25)	
Connecting Rod Journal	Diameter		2.0988 - 2.0998 (53.3095 - 53.3349)		2.1985 - 2.1995 (55.8419 - 55.8673)	
	Taper	Production	.0005 (.0127) Max.			
		Service	.001 (.025) Max.			
	Out of Round	Production	.0005 (.0127) Max.			
		Service	.001 (.025) Max.			
Rod Bearing Clearance		Production	.0013 - .0035 (.0330 - .0889)		.0009 - .0025 (.0229 - .0635)	
		Service	.003 (.07) Max.			
Rod Side Clearance			.008 - .014 (.2 - .35)		.013 - .023 (.35 - .55)	
Crankshaft Runout			.0015 (.0381) Max.			

Engine	305 CID	350 CID	454 CID (Standard)	454 CID (Hi-Performance)

Camshaft and Drive:

Lobe Lift ± .002 (.051)	Intake	.263 (6.680)	.271 (6.883)	.294 (7.468)
	Exhaust	.269 (6.833)	.282 (7.163)	.294 (7.468)
Journal Diameter		1.8682 - 1.8692 (47.452 - 47.478)	1.9482 - 1.9492 (49.484 - 49.510)	
Journal Out-of-Round		.001 (.025) Max.		
Camshaft Runout		.002 (.051) Max.		
Timing Chain Deflection [L.H. (Standard) Rotation Engines Only]		3/8 (10) From Taut Position [3/4 (19) Total]		
Camshaft End Play [R.H. (Opposite) Rotation Engines Only]			.001 - .005 (.03 - .1)	
Camshaft Timing Gear Runout [R.H. (Opposite) Rotation Engines Only]		.004 (.102) Max.		
Crankshaft Timing Gear Runout [R.H. (Opposite) Rotation Engines Only]		.003 (.076) Max.		
Camshaft to Crankshaft Timing Gear Backlash [R.H. (Opposite) Rotation Engines Only]		.004 - .006 (.102 - .152) New Gears .004 - .008 (.102 - .203) Used Gears		

Cylinder Head:

Gasket Surface Flatness	.003 (.07) in 6 (152) .007 (.15) Overall Maximum

Flywheel:

Runout	.008 (.203) Max.

Engine	305 CID	350 CID	454 CID (Standard)	454 CID (Hi-Performance)

Valve System:

Lifter Type			Hydraulic		
Rocker Arm Ratio			1.50 to 1	1.70 to 1	
Valve Lash (Intake & Exhaust)			1 Turn Down from Zero Lash		(Note 1)
Face Angle (Intake & Exhaust)			45°		
Seat Angle (Intake & Exhaust)			46°		
Seat Runout (Intake & Exhaust)			.002 (.051) Max.		
Seat Width	Intake		1/32 - 1/16 (.79 - 1.59)		
	Exhaust		1/16 - 3/32 (1.59 - 2.38)		
Stem Clearance	Production	Intake	.001 - .0027 (.0254 - .0686)		
		Exhaust	.001 - .0027 (.0254 - .0686)	.0012 - .0029 (.0305 - .0737)	
	Service	Intake	.0037 (.0940)		
		Exhaust	.0047 (.1194)	.0049 (.1245)	

NOTE 1: Conventional rocker arms, 1 turn down from zero lash;
Roller rocker arms, see page 6C-42.

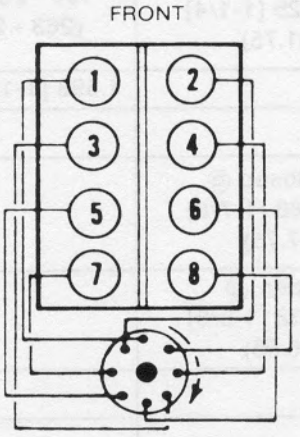
Engine				305 CID	350 CID	454 CID (Standard)	454 CID (Hi-Performance)
Valve Spring:							
Valve Spring (Note 1)	Spring 24-72642 (With 2 Light Green Stripes)	Free Length		1.91 [1-29/32] (48.5)			
		Pressure (Note 2)	Closed @ 1.61 [1-39/64] (40.89)	76 - 84 Lbs. Ft. (103 - 114 N.m)			
			Open @ 1.16 [1-5/32] (29.46)	194 - 206 Lbs. Ft. (263 - 279 N.m)			
		Installed Height		1.718 [1-23/32] (43.7)			
	Spring 24-48437 (With 1 Lavender Stripe)	Free Length		2.03 [2-1/32] (51.6)			
		Pressure (Note 2)	Closed @ 1.70 [1-45/64] (43.16)	76 - 84 Lbs. Ft. (103 - 114 N.m)			
			Open @ 1.25 [1-1/4] (31.75)	194 - 206 Lbs. Ft. (263 - 279 N.m)			
		Installed Height		1.593 [1-19/32] (40.5)			
	Spring 24-75584 (Single Spring)	Free Length				2.12 [1-1/8] (53.8)	
		Pressure (Note 2)	Closed @ 1.88 [1-7/8] (47.75)			74 - 86 Lbs. Ft. (100 - 116 N.m)	
			Open @ 1.38 [1-3/8] (35.05)			288 - 312 Lbs. Ft. (390 - 423 N.m)	
		Installed Height				1.875 [1-7/8] (47.6)	
	Spring Assembly 24-88154 (With 2 Springs)	Free Length					Outer - 2.250 [2-1/4] (57.2) Inner - 2.125 [2-1/8] (54.0)
		Pressure (Note 3)	Closed @ 1.88 [1-7/8] (47.75)				115 - 125 Lbs. Ft. (156 - 169 N.m)
			Open @ 1.38 [1-3/8] (35.05)				305 - 325 Lbs. Ft. (414 - 440 N.m)
		Installed Height					1.875 [1-7/8] (47.6)
Damper	Free Length			1.86 [1-55/64] (47.24)			
	Approximate No. of Coils			4			

NOTE 1: Refer to information under "Cylinder Heads", to determine which valve spring is being used.
NOTE 2: Test spring pressure with damper removed.
NOTE 3: Test spring pressure with inner and outer springs and damper assembled.

HI-PERFORMANCE ENGINE SPECIFICATIONS

UNIT OF MEASUREMENT
in. (mm)

Model	400 Cyclone	440 Cyclone	460 Cyclone	475 Turbo
Displacement	454 CID	454 CID	482 CID	454 CID
Bore	4.250 (107.95)	4.250 (107.95)	4.250 (107.95)	4.250 (107.95)
Stroke	4.000 (101.6)	4.000 (101.6)	4.250 (107.95)	4.000 (101.6)
Compression Ratio	8.6:1	8.6:1	9.2:1	7.0:1



Firing Order
1-8-4-3-6-5-7-2

Figure 1. Left-Hand Rotation Engine

Engine	400 Cyclone	440 Cyclone	460 Cyclone	475 Turbo

Cylinder Bore:

Diameter			4.2451 - 4.2525 (107.8255 - 108.0135)
Out of Round	Production		.001 (.025) Max.
	Service		.002 (.05) Max.
Taper	Production	Thrust Side	.0005 (.0127) Max.
		Relief Side	.001 (.025) Max.
	Service		.001 (.025) Max.

Piston:

Clearance	Production	.0045 - .0065 (.1143 - .1651)	.008 - .0095 (.2032 - .2413)
	Service	.0075 (.15) Max.	.008 - .0095 (.2032 - .2413)

Piston Ring:

Compression	Groove Side Clearance	Production	Top	.0017 - .0032 (.04 - .08)
			2nd	.0017 - .0032 (.04 - .08)
		Service		Hi Limit Production + .001 (.025)
	Gap	Production	Top	.010 - .020 (.25 - .5)
			2nd	.010 - .020 (.25 - .5)
		Service		Hi Limit Production + .010 (.25)
Oil	Groove Side Clearance	Production		.005 - .0065 (.127 - .165)
		Service		Hi Limit Production + .001 (.025)
	Gap	Production		.020 - .035 (.5 - .85)
		Service		Hi Limit Production + .010 (.25)

Piston Pin:

Diameter		.9895 - .9898 (25.1333 - 25.1409)	.9900 - .9903 (25.146 - 25.1536)
Clearance	Production	.00025 - .00035 (.00635 - .00889)	.0006 - .001 (.01524 - .0254)
	Service	.001 (.02) Max.	.0012 (.03)
Fit in Rod		.0008 - .0016 (.0203 - .0406) Interference	

Engine			400 Cyclone	440 Cyclone	460 Cyclone	475 Turbo
Crankshaft:						
Main Journal	Diameter	No. 1	2.7485 - 2.7494 (69.8119 - 69.8348)			
		No. 2, 3, 4	2.7481 - 2.7490 (69.8017 - 69.8246)			
		No. 5	2.7478 - 2.7488 (69.7941 - 69.8195)			
	Taper	Production	.0002 (.0051) Max.			
		Service	.001 (.025) Max.			
	Out of Round	Production	.0002 (.0051) Max.			
		Service	.001 (.025) Max.			
Main Bearing Clearance	Production	No. 1, 2, 3, 4	.0013 - .0025 (.0330 - .0635)			
		No. 5	.0024 - .0040 (.0610 - .1016)			
	Service	No. 1	.001 - .0015 (.03)			
		No. 2, 3, 4	.001 - .0025 (.03 - .06)			
		No. 5	.0025 - .0035 (.07 - .08)			
Crankshaft End Play			.006 - .010 (.15 - .25)			
Connecting Rod Journal	Diameter		2.1985 - 2.1995 (55.8419 - 55.8673)			
	Taper	Production	.0005 (.0127) Max.			
		Service	.001 (.025) Max.			
	Out of Round	Production	.0005 (.0127) Max.			
		Service	.001 (.025) Max.			
Rod Bearing Clearance		Production	.0009 - .0025 (.0229 - .0635)			
		Service	.003 (.07) Max.			
Rod Side Clearance			.013 - .023 (.35 - .55)			
Crankshaft Runout			.0015 (.0381) Max.			

Engine		400 Cyclone	440 Cyclone	460 Cyclone	475 Turbo
Camshaft and Drive:					
Lobe Lift ± .002 (.051)	Intake	.312 (7.925)	.323 (8.204)		.294 (7.468)
	Exhaust	.324 (8.230)	.328 (8.331)		.294 (7.468)
Journal Diameter		1.9482 - 1.9492 (49.484 - 49.510)			
Journal Out-of-Round		.001 (.025) Max.			
Camshaft Runout		.002 (.051) Max.			
Timing Chain Deflection [L.H. (Standard) Rotation Engines Only]		3/8 (10) From Taut Position [3/4 (19) Total]			
Cylinder Head:					
Gasket Surface Flatness		.003 (.07) in 6 (152) .007 (.15) Overall Maximum			
Flywheel:					
Runout		.008 (.203) Max.			

Engine	400 Cyclone	440 Cyclone	460 Cyclone	475 Turbo

Valve System:

Lifter Type			Hydraulic
Rocker Arm Ratio			1.70 to 1
Valve Lash (Intake & Exhaust)			Roller rocker arms - see page 6C-42
Face Angle (Intake & Exhaust)			45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			.002 (.051) Max.
Seat Width	Intake		1/32 - 1/16 (.79 - 1.59)
	Exhaust		1/16 - 3/32 (1.59 - 2.38)
Stem Clearance	Production	Intake	.001 - .0027 (.0254 - .0686)
		Exhaust	.0012 - .0029 (.0305 - .0737)
	Service	Intake	.0037 (.0939)
		Exhaust	.0049 (.1244)

Engine	400 Cyclone	440 Cyclone	460 Cyclone	475 Turbo

Valve Spring:

Valve Spring	Spring 24-62074 (No Paint Stripe)	Free Length		2.210 [2-13/64] (56.1)		
		Pressure (Note 1)	Closed @ 1.875 [1-7/8] (47.63)	115 Lbs. Ft. (156 N.m)		
			Open @ 1.375 [1-3/8] (34.92)	340 Lbs. Ft. (461 N.m)		
		Installed Height		1.843 [1-27/32] (46.8)		
	Spring 24-69288 (White and Light Blue Stripe)	Free Length				2.350 [2-11/32] (59.69)
		Pressure (Note 2)	Closed @ 1.875 [1-7/8] (47.63)			155 Lbs. Ft. (210 N.m)
			Open @ 1.375 [1-3/8] (34.92)			340 Lbs. Ft. (461 N.m)
		Installed Height				1.906 [1-29/32] (48.4)

NOTE 1: Test spring pressure with inner and outer springs assembled.
NOTE 2: Test spring pressure with inner and outer springs and damper assembled.

GENERAL

Some repairs, that are listed in this section, must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

Lubricate all moving parts (during reassembly) with engine oil. Apply Perfect Seal on threads of and under head of cylinder head bolts and on threads of all cylinder block external bolts, screws and studs.

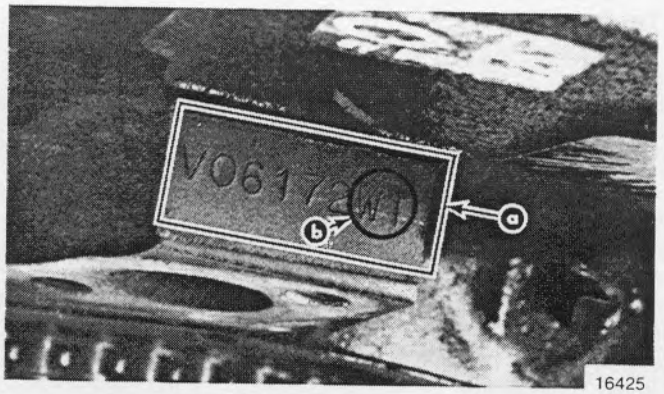
Model	No. of Cylinders	Cu. In. Displacement
MCM 898	V-8	305 (5 ltr)
MCM/MIE 228	V-8	305 (5 ltr)
MIE 230	V-8	305 (5 ltr)
MIE 255	V-8	350 (5.7 ltr)
MCM/MIE 260	V-8	350 (5.7 ltr)
MCM/MIE 330	V-8	454 (7.4 ltr)
MIE 340	V-8	454 (7.4 ltr)
MCM 370/ 400TRS	V-8	454 (7.4 ltr)

Cubic Inch Displacement (CID) of each MerCruiser model

ENGINE IDENTIFICATION

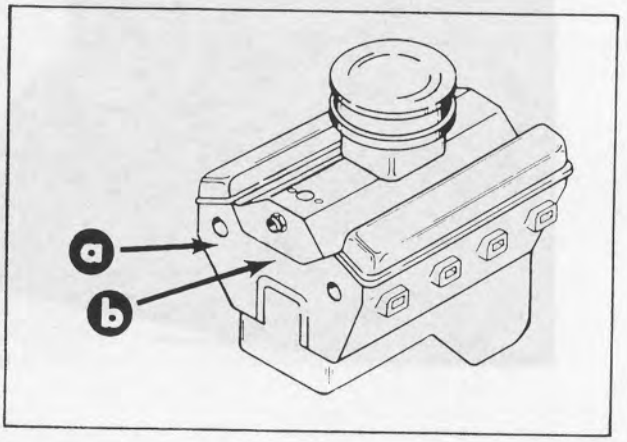
The MerCruiser Model can be determined by looking at the LAST TWO LETTERS of the engine code stamped into the cylinder block. (Figure 1) This code number is stamped on all MerCruiser Power Packages and replacement partial engines but not replacement cylinder block assemblies.

If the engine serial number, and/or model decals are missing, the engine code letters may help in determining the engine model. Following is a list of G.M. engines and their respective code letters.



a - Engine Code (V06172WT)
b - Last Two Letters (WT)

Figure 1. G.M. Engine Code



a - Small Block V-8 - Front, Starboard Side, Near Cylinder Head Mating Surfaces
b - Large Block V-8 - Front of Engine Just Above Timing Gear/ Chain Cover

Figure 2. G.M. Engine Code Location

MCM Stern Drive Engines (All Are L.H. Rotation)

898-MN or MX	330-XS
228-MJ or MY	330 (B-W)-XY
255-WH or WN	370-XF
260-WT	

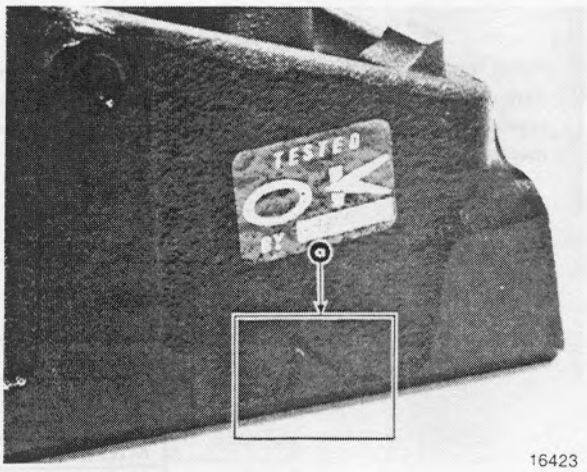
MIE Inboard Engines (Either Rotation)

L.H. (Standard) Rotation

228-MA	260-WN
230-MA	330-XN or XY
255-WH or WN	340-XY

R.H. (Opposite) Rotation

228-MB	260-WR
230-MB	330-XR or XZ
255-WJ or WR	340-XZ



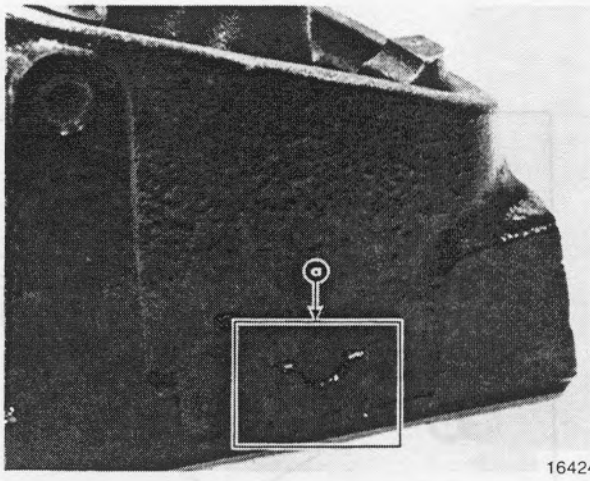
16423

a.

Figure 4. 350 CID Engines (255, 260)

CYLINDER HEAD IDENTIFICATION - 305/350 CID Engines (1978-1984)

The identification mark is located on both ends of the cylinder head.



16424

a.

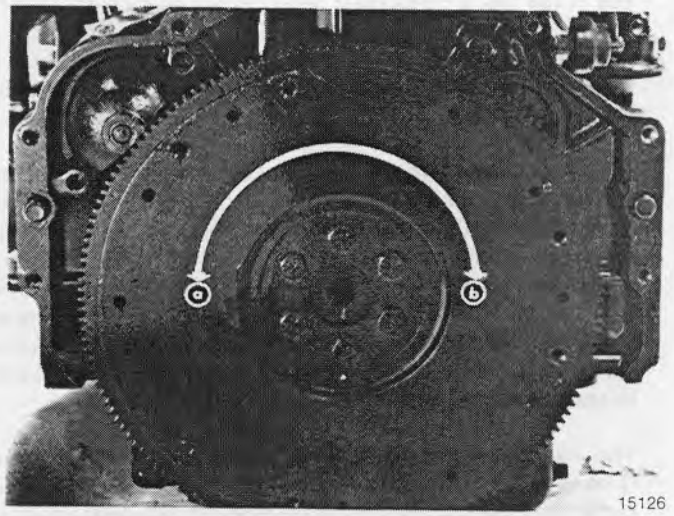
Figure 3. 305 CID Engines (898, 228, 230)

ENGINE ROTATION

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



15126

a - Left Hand Rotation (CCW) - All Stern Drive Engines, MIE Inboard L.H. (Standard) Rotation
b - Right Hand Rotation (CW) - MIE Inboard R.H. (Opposite) Rotation

CRANKSHAFT

The crankshaft is supported in the block by five insert type bearings. Crankshaft end thrust is controlled by flanges on the number five bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

PISTON and CONNECTING RODS

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft thru insert type bearings.

CAMSHAFT and DRIVE

Camshaft is supported by five bearings, which are pressed into the block, and is driven at one-half crankshaft speed by a timing chain and sprockets or by timing gears.

Taper on lobes coupled with spherical foot on hydraulic valve lifters, causes the valve lifters to rotate, thus reducing wear. A helical gear on the aft end of the camshaft drives the distributor and oil pump, while an eccentric cam on the front of the camshaft actuates the fuel pump.

CYLINDER HEAD

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or composition head gaskets are used to retard corrosion.

VALVE TRAIN

The valves and valve springs are of a heavy-duty design to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used on all engines except the (hi-performance 454 CID engines) to help extend valve life.

Hydraulic valve lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods which in turn actuate the valves thru the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serves to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The valve lifters also are used to lubricate the valve train bearing surfaces.

INTAKE MANIFOLD

The manifold is of the double level design for efficient fuel distribution. The upper level of passages feeds cylinders 2, 3, 5 and 8 while the lower level passages feed cylinders 1, 4, 6 and 7. All passages are of approximately equal length to assure more even fuel-air mixture to the cylinders.

LUBRICATION SYSTEM

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into system. Once the oil reaches the pump, the pump forces the oil thru the lubrication system. A spring loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows thru a full-flow oil filter. On engines with an engine oil cooler, the oil also flows thru the cooler before returning to the block. A bypass valve (on all engines except hi-performance 454 CID) allows oil to bypass the filter and oil cooler should they become restricted. A bypass valve is not used on hi-performance 454 CID engines to ensure that all of the oil is filtered.

On 305 and 350 CID engines, some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 5 crankshaft main bearing. The remainder of the oil is routed to the main oil gallery, which is located directly above the camshaft and runs the entire length of the block. From the main oil gallery, the oil is routed thru individual oil passages to an annular groove in each camshaft bearing bore. Some of the oil is then used to lubricate camshaft bearings. The remainder of the oil is routed to the valve lifter oil galleries and No. 1, 2, 3, and 4 crankshaft main bearings by means of individual oil passages which intersect with the annular grooves.

On 454 CID engines, some of the oil, after leaving the oil cooler and/or filter, is routed to the main oil gallery, on the left side of the cylinder block, which supplies oil thru individual passages to the No. 1, 2, 3 and 4 crankshaft main bearings and the No. 1, 2, 3 and 4 camshaft bearings. The remainder of the oil is routed to the No. 5 crankshaft main bearing and to an annular groove in the No. 5 camshaft bearing bore. Some of the oil is then used to lubricate the camshaft bearing, while the remainder is routed to both valve lifter oil galleries thru oil passages which intersect the annular groove.

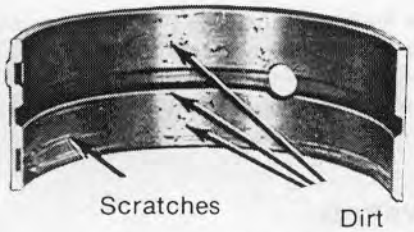
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow in between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto camshaft drive and keeps it lubricated.

The oil which reaches the crankshaft main bearings is forced thru a hole in the upper half of each bearing and flows in-between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings thru grooves in the upper half of the crankshaft main bearings and oil passages in crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil which is forced out the front end of the No. 1 crankshaft main bearing also assists in lubricating the camshaft drive. A baffle plate, mounted on the bottom of the main bearings or in the oil pan, prevents oil thrown from the crankshaft and connecting rods from areating the oil in the oil pan.

Oil which reaches the valve lifters oil galleries is forced into each hydraulic valve lifter thru holes in the side of the lifter. From here, the oil is forced thru the metering valve in each of the lifters (which controls the volume of oil flow) and then up thru the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass thru the rocker arm and lubricate the valve train bearing surfaces. After lubricating valve train, oil drains back to the oil pan thru oil returns holes in the cylinder head and block.

The distributor shaft and gear also is lubricated by the oil flowing thru the right valve lifter oil gallery. Fuel pump push rod is lubricated by oil thrown off from the camshaft eccentric.

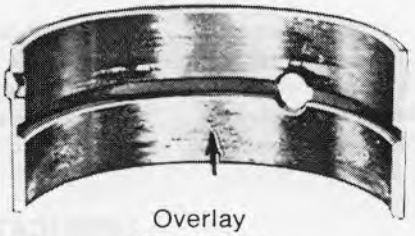
BEARING FAILURES



Scratches

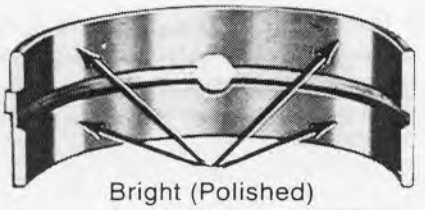
Dirt Imbedded into Bearing Material

SCRATCHED BY DIRT



Overlay Wiped Out

LACK OF OIL

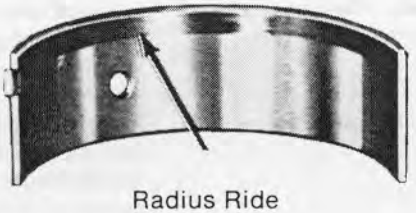


Bright (Polished) Sections

IMPROPER SEATING

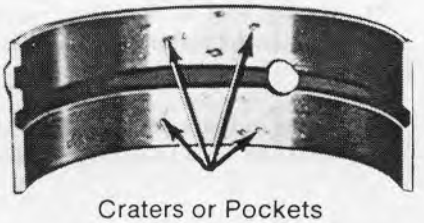
Overlay Gone from Entire Surface

TAPERED JOURNAL



Radius Ride

RADIUS RIDE



Craters or Pockets

FATIGUE FAILURE

PISTON FAILURES

PRE-IGNITION

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion of the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature. (Figure 1)

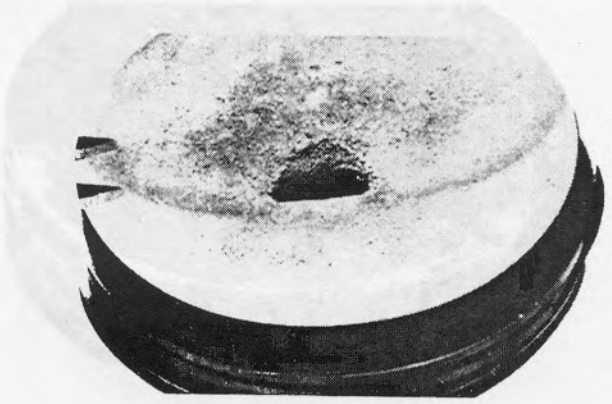
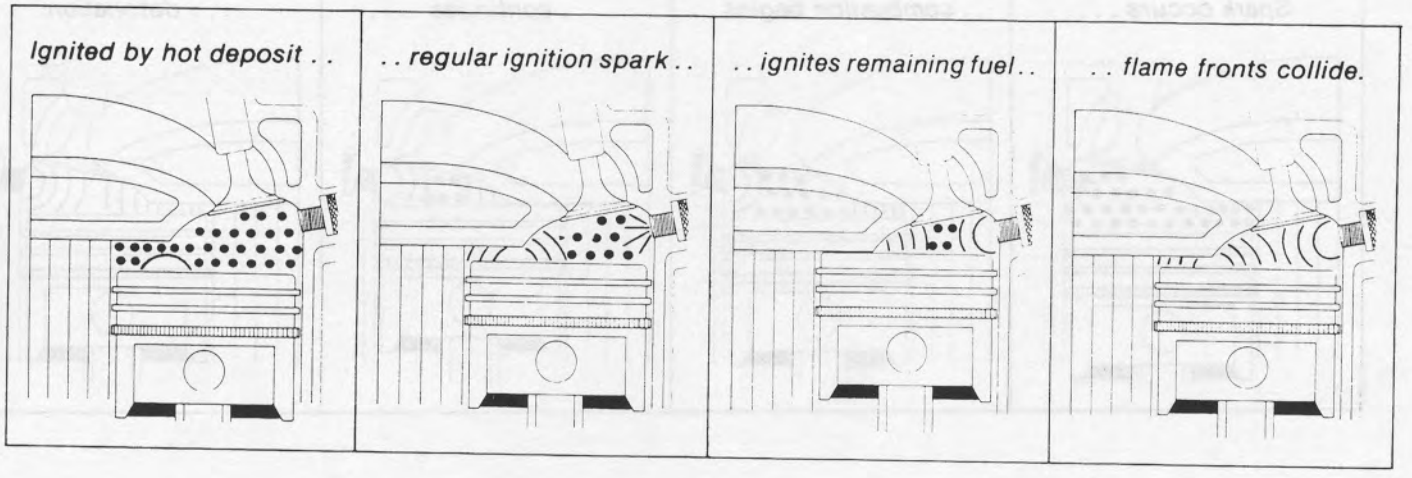


Figure 1. Pre-Ignition Damage

Pre-Ignition Causes

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.



DETONATION

Detonation, commonly called "fuel knock", "spark knock" or "carbon knock", is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition. (Figure 2)

Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

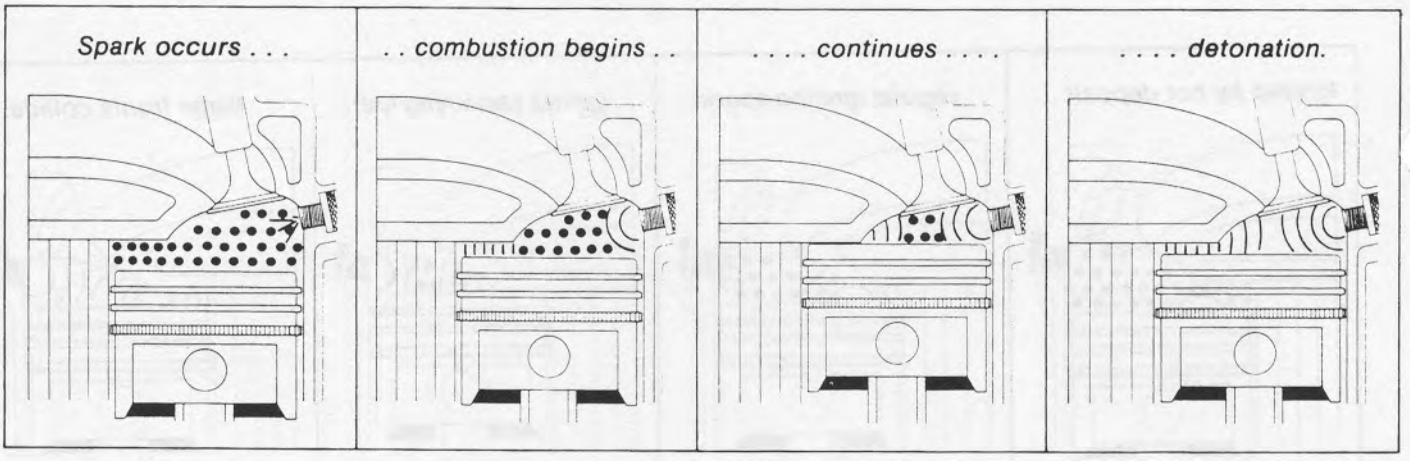
Other Causes of Detonation

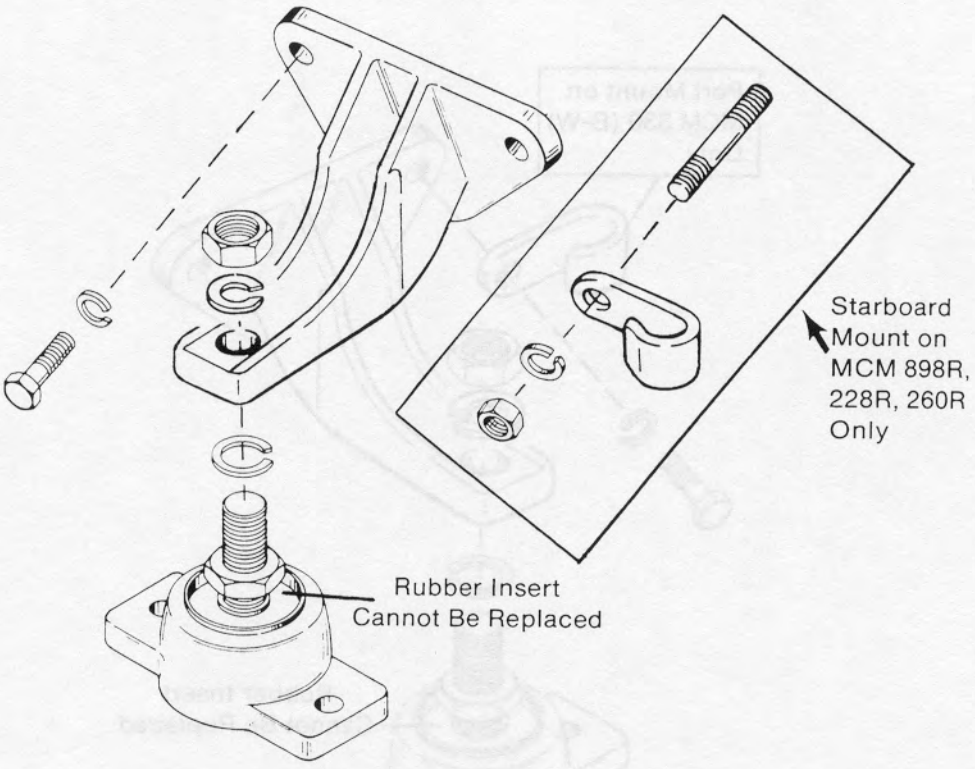
IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

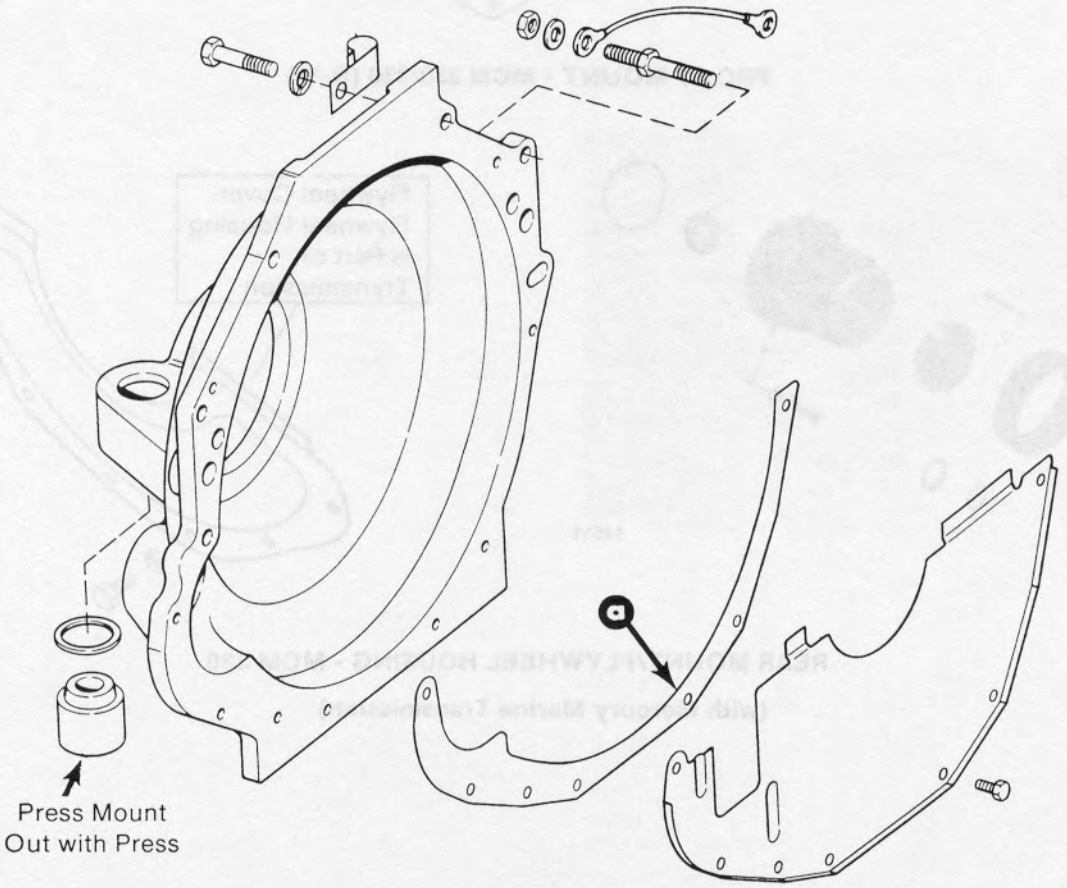
Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.

Figure 2. Detonation Damage



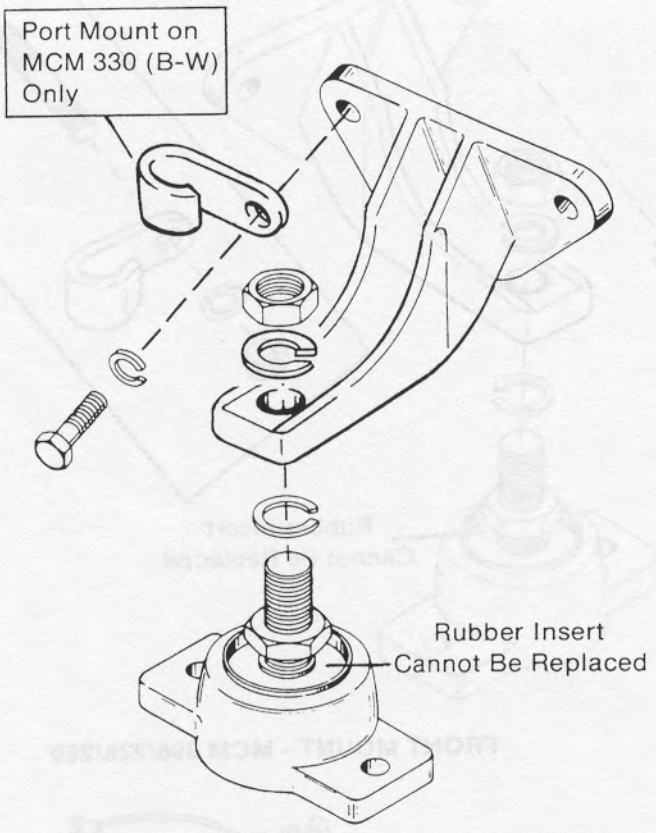


FRONT MOUNT - MCM 898/228/260

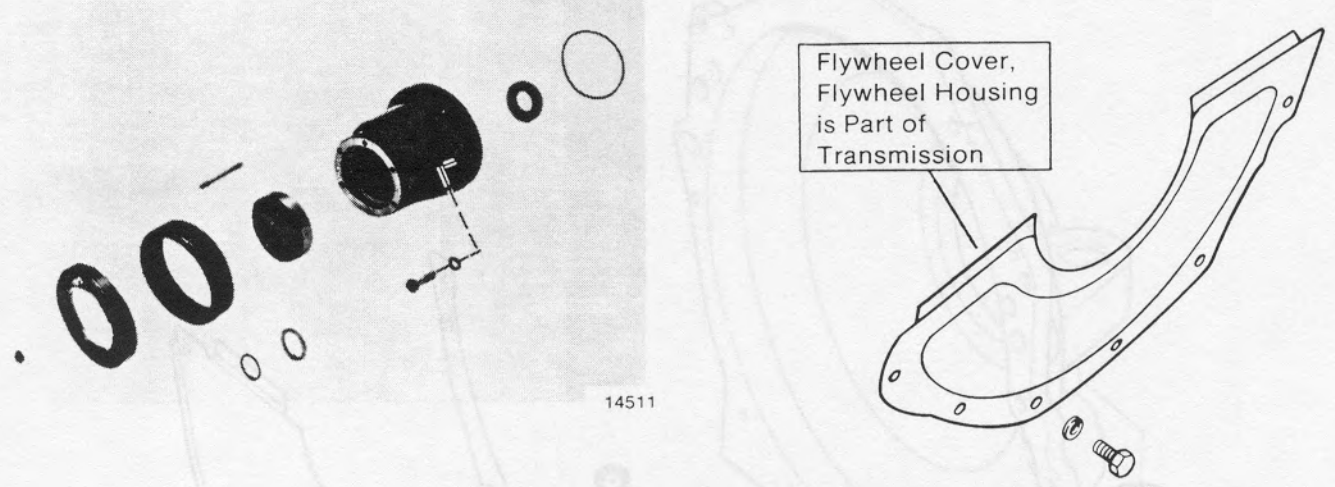


a - Gasket used on MCM 898R/228R/260R Engines Only

REAR MOUNT/FLYWHEEL HOUSING - MCM 898/228/260

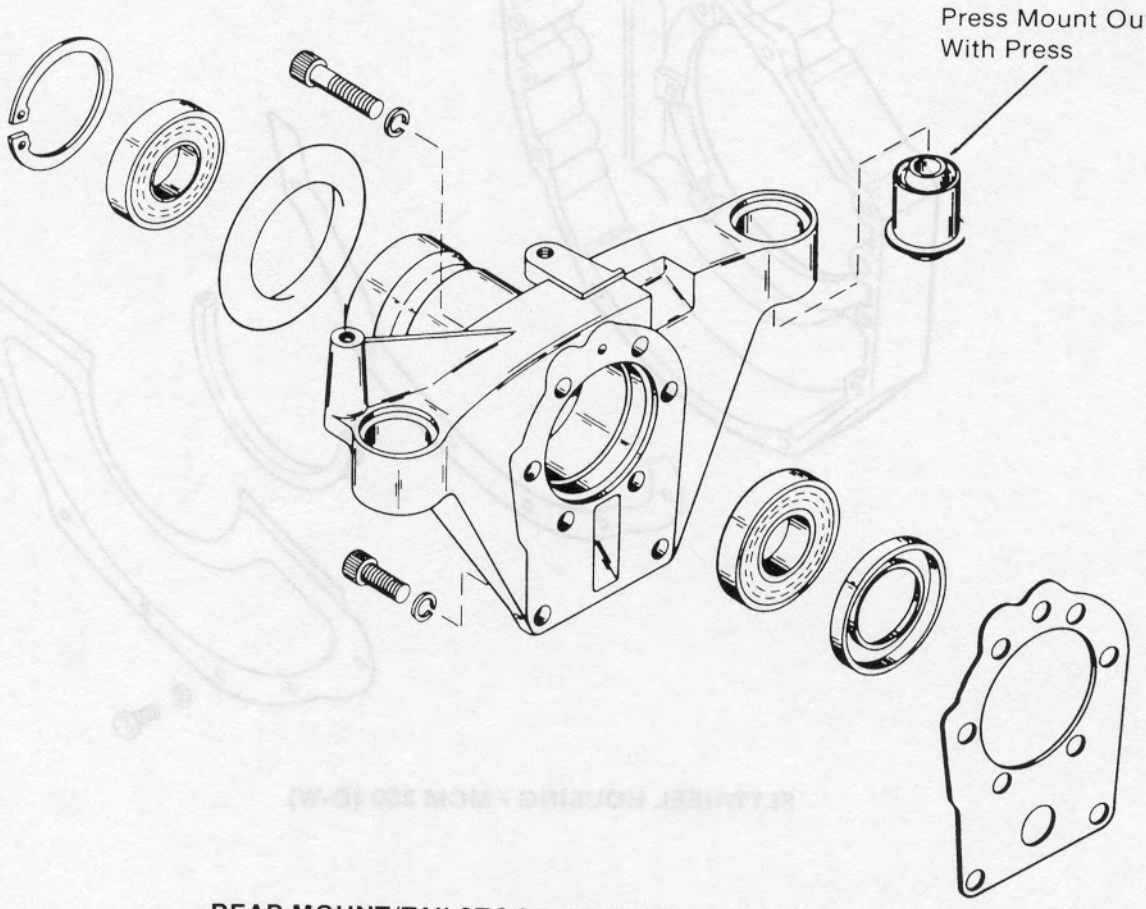


FRONT MOUNT - MCM 330/330 (B-W)

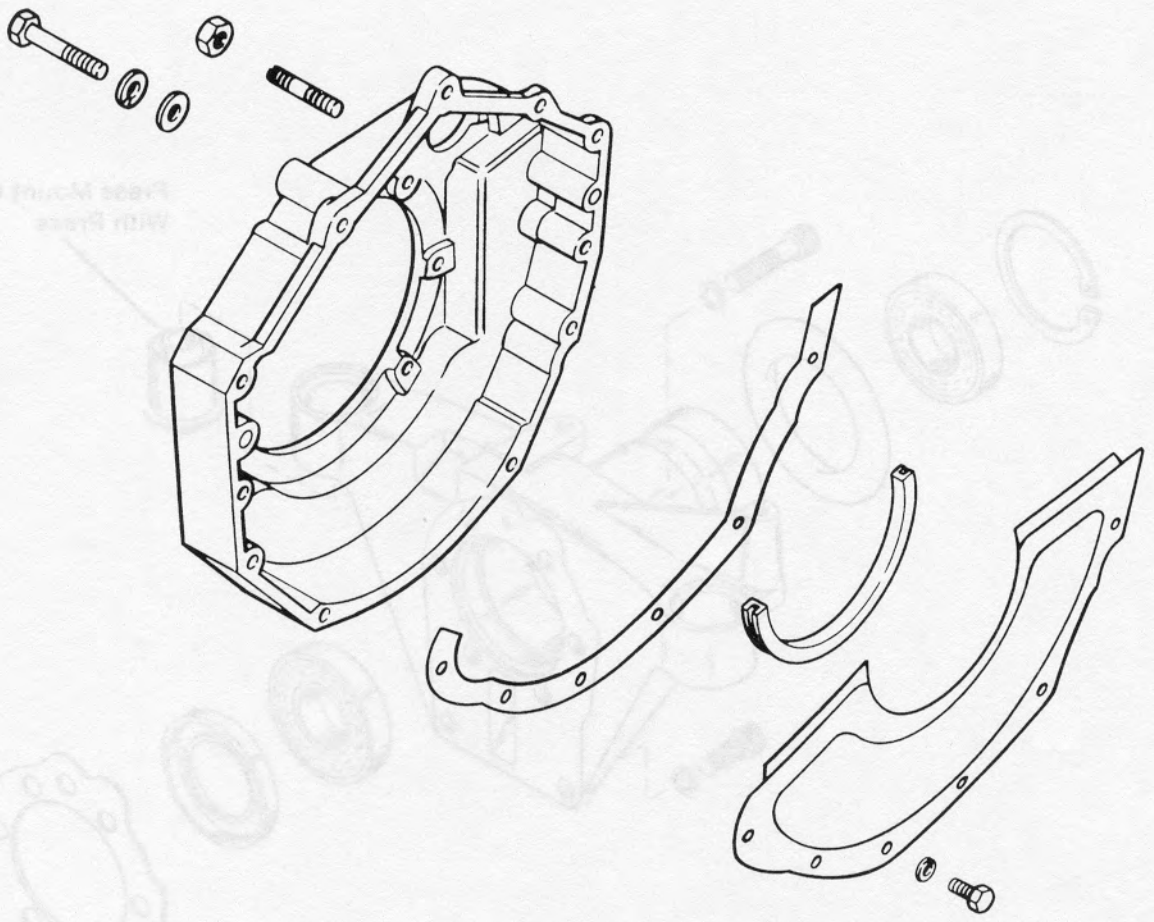


REAR MOUNT/FLYWHEEL HOUSING - MCM 330

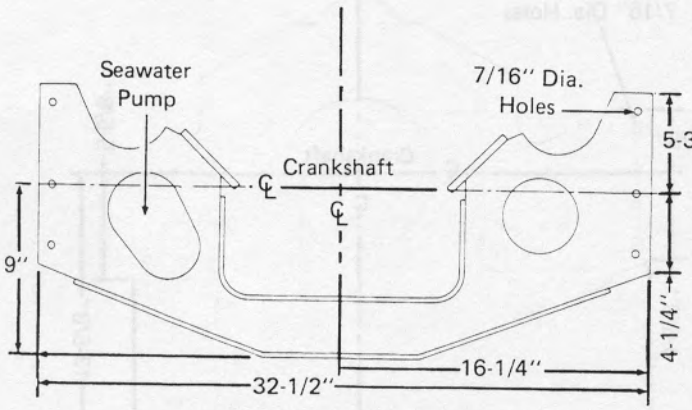
(with Mercury Marine Transmission)



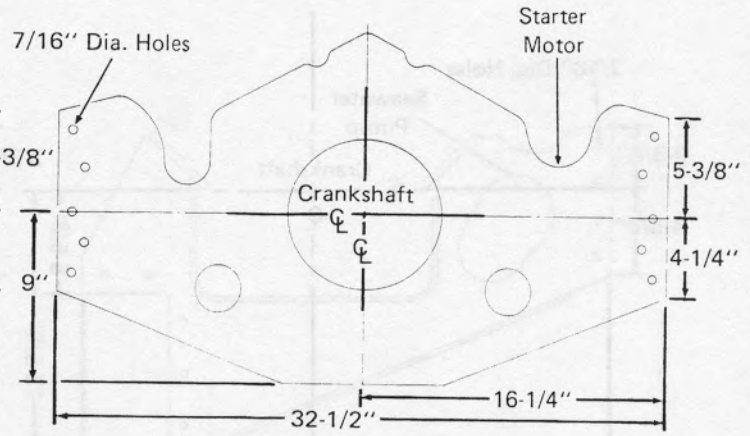
REAR MOUNT/TAILSTOCK ASSEMBLY - MCM 330 (B-W)



FLYWHEEL HOUSING - MCM 330 (B-W)

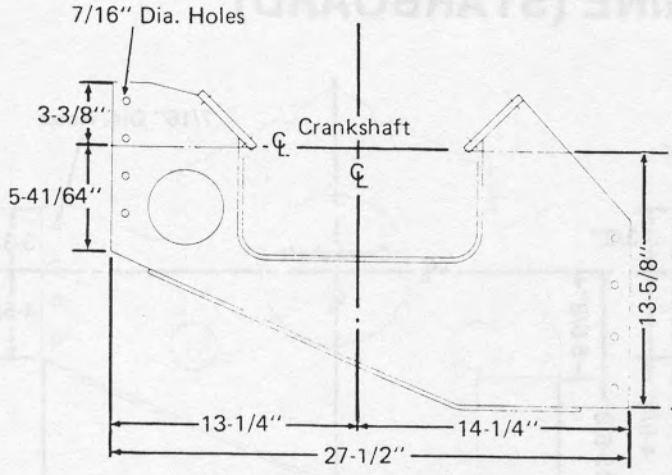


FRONT MOUNT
49863

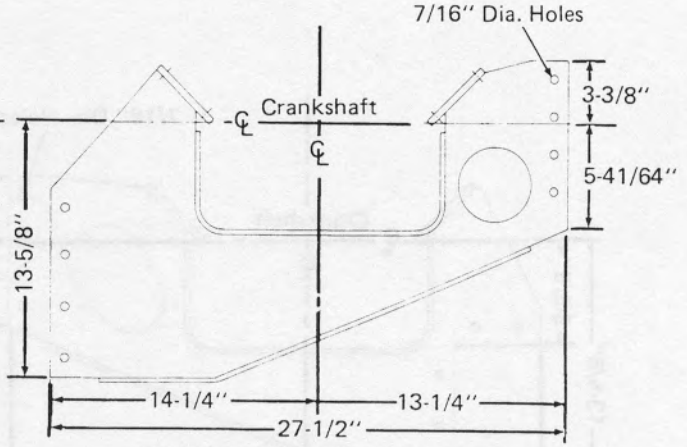


REAR MOUNT
49864

SINGLE ENGINES



FRONT MOUNT
STARBOARD ENGINE
72515

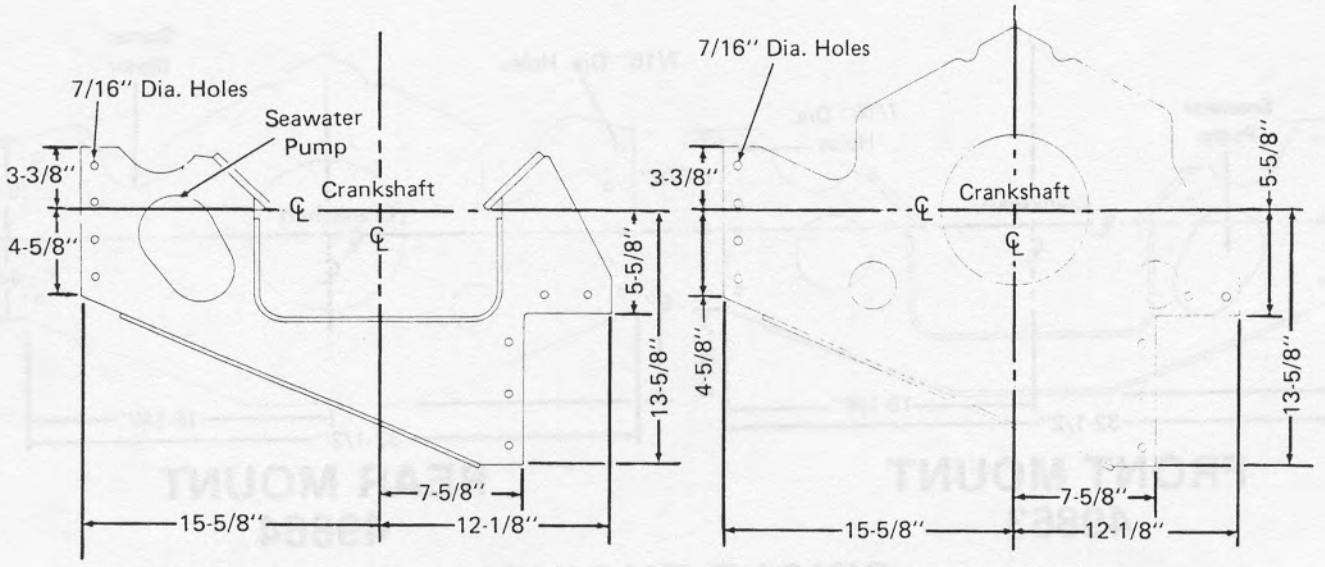


FRONT MOUNT
PORT ENGINE
72514

SIDE BY SIDE ENGINES

Note: View of Mount is From Front of Engine, Looking Toward Transom.

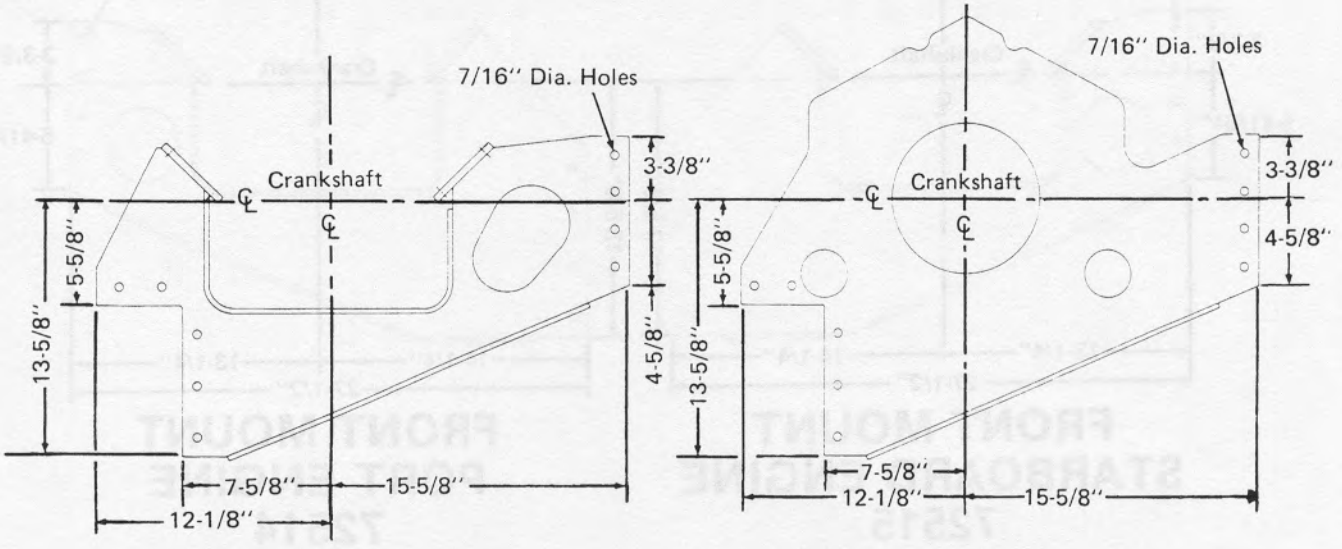
MOUNTING PLATES - MCM 370/Hi-Performance 454/482 CID Engines



FRONT MOUNT
49865

REAR MOUNT
49866

STAGGERED ENGINE (STARBOARD)



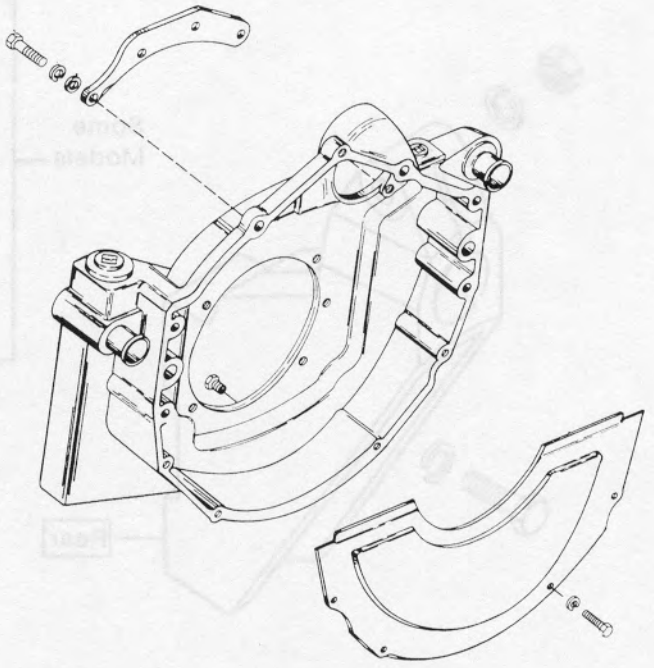
FRONT MOUNT
88665

REAR MOUNT
49866

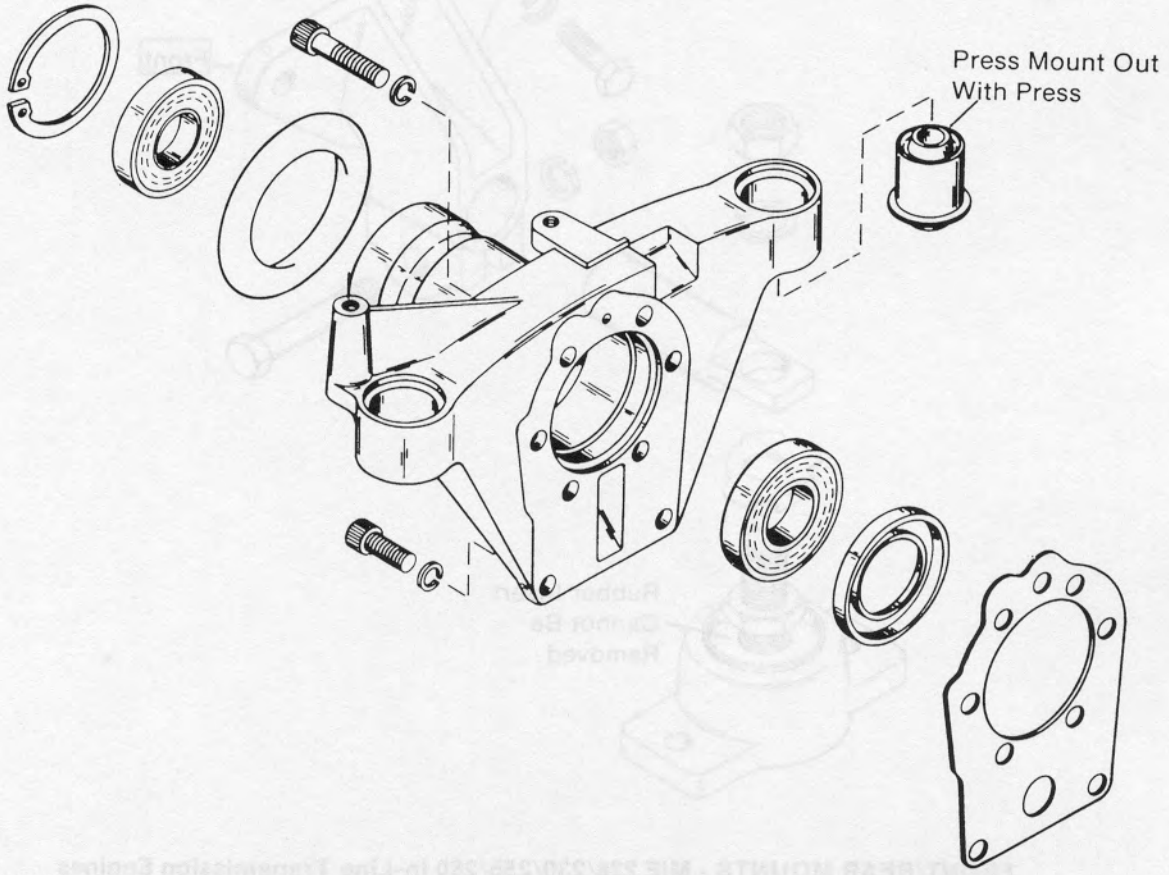
STAGGERED ENGINE (PORT)

Note: View of Mount is From Front of Engine, Looking Toward Transom.

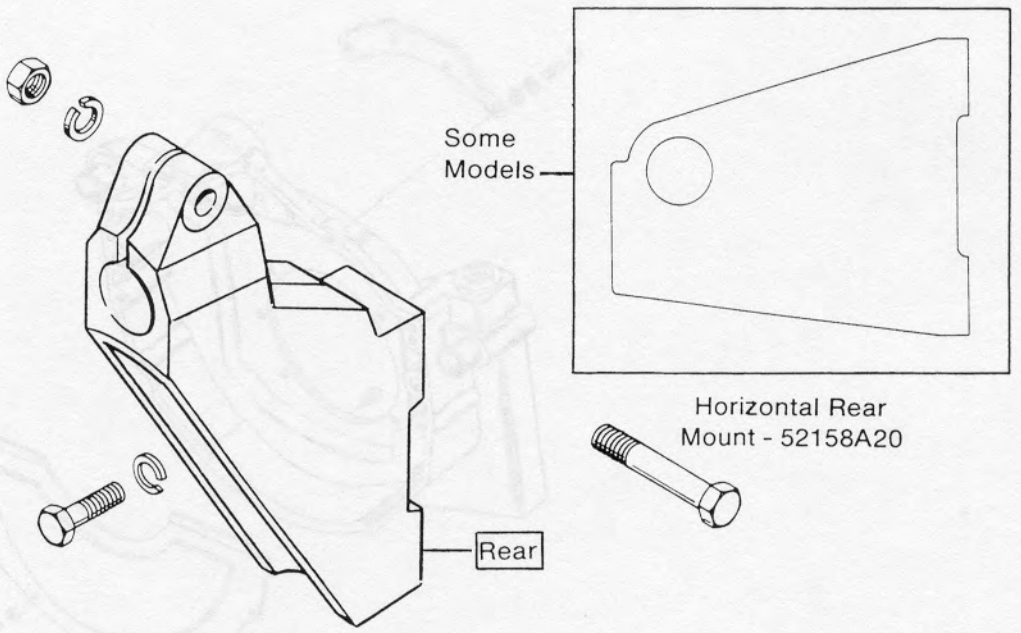
MOUNTING PLATES FOR STAGGERED ENGINES - MCM 370/Hi-Performance 454/482 CID Engines



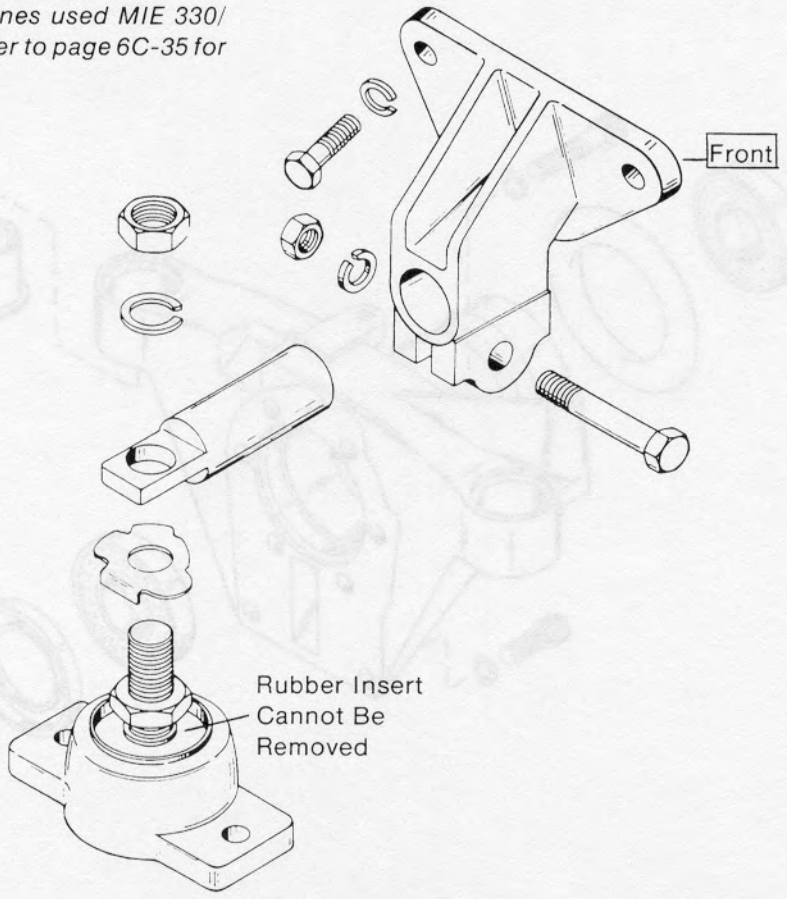
FLYWHEEL HOUSING — MCM 370/Hi-Performance 454/482 CID Engines



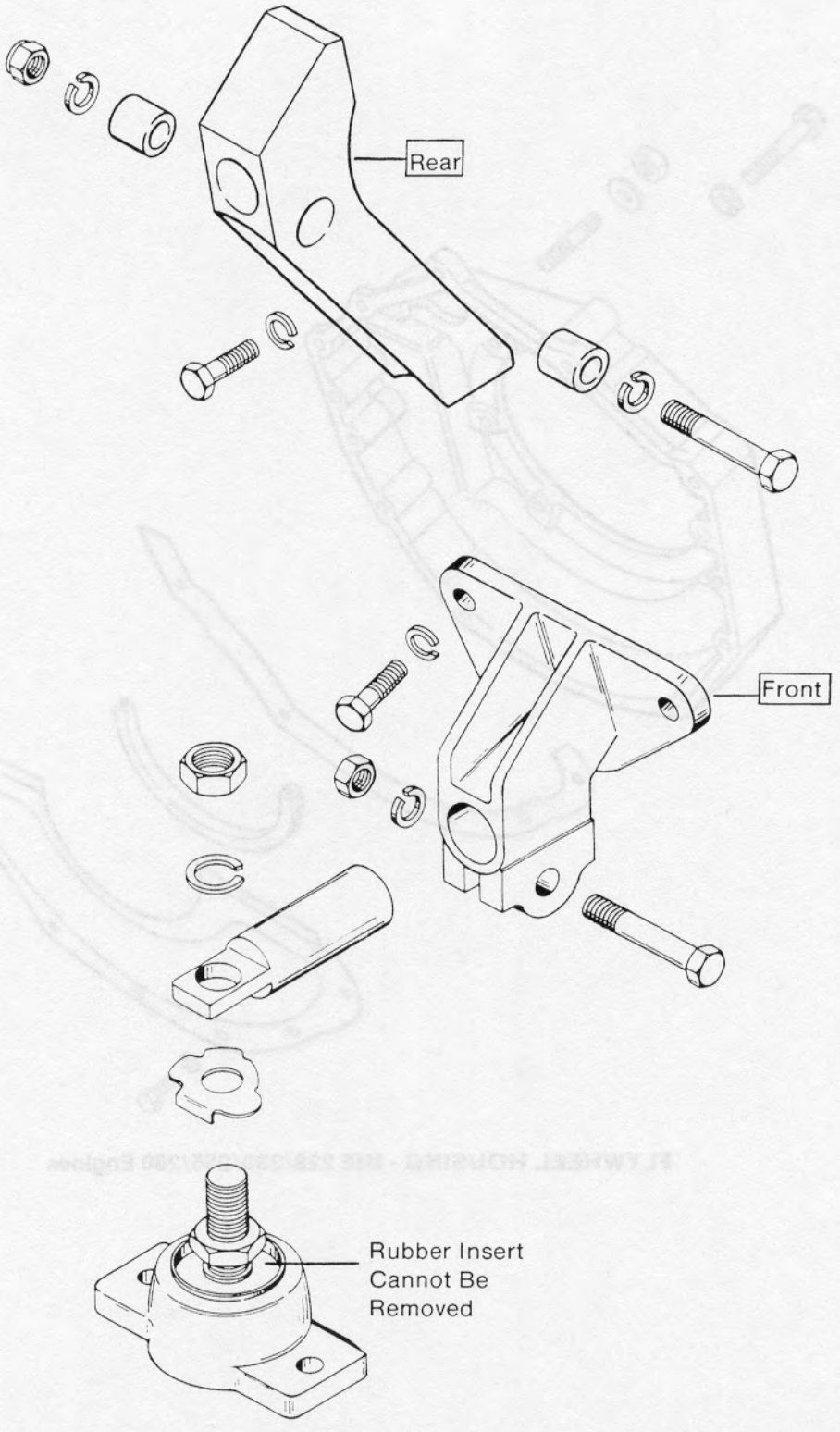
REAR MOUNT/TAILSTOCK ASSEMBLY - MCM 370/Hi-Performance 454/482 CID Engines (Some Models)



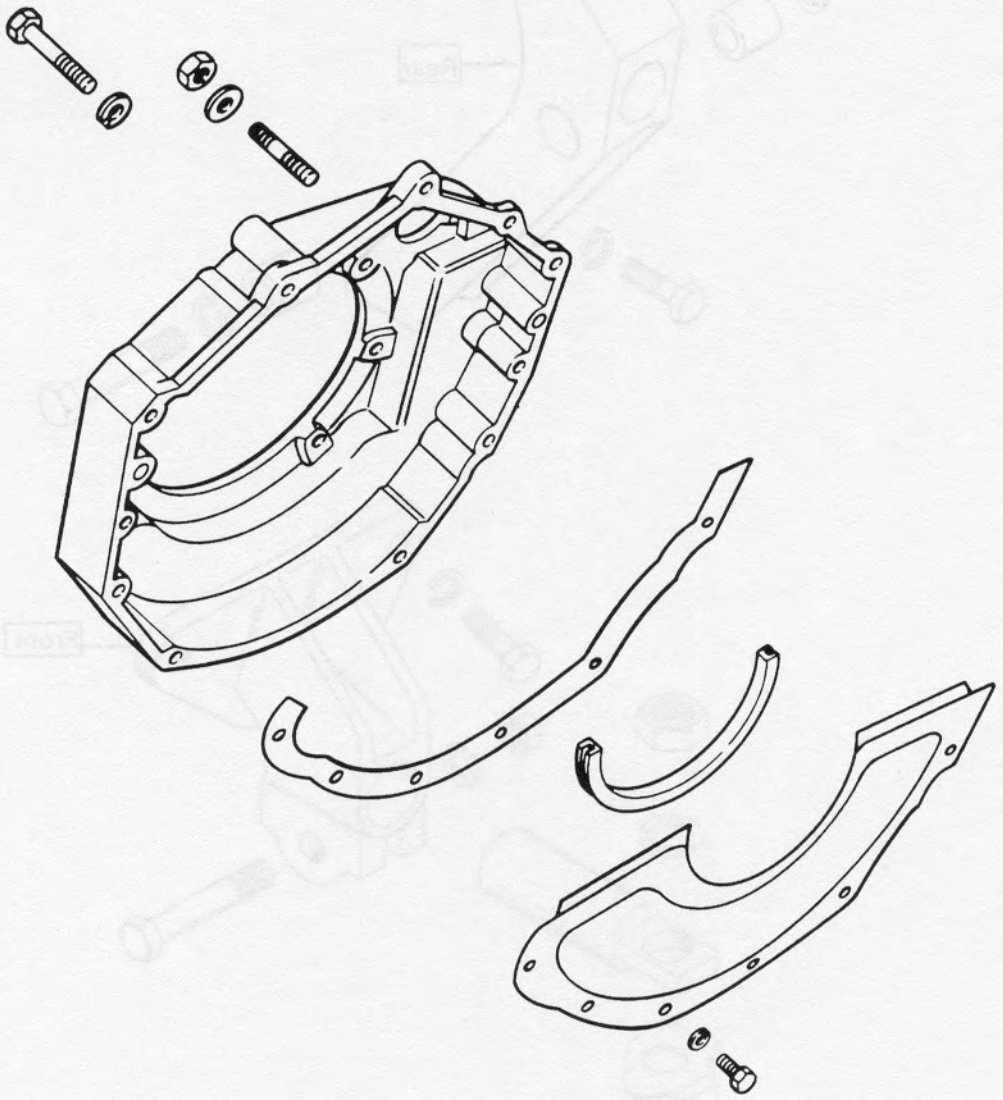
NOTE: Center of lower mounting hole is 1-1/4" (32mm) up from bottom of casting. Some engines used MIE 330/340 rear mount. Refer to page 6C-35 for dimensions.



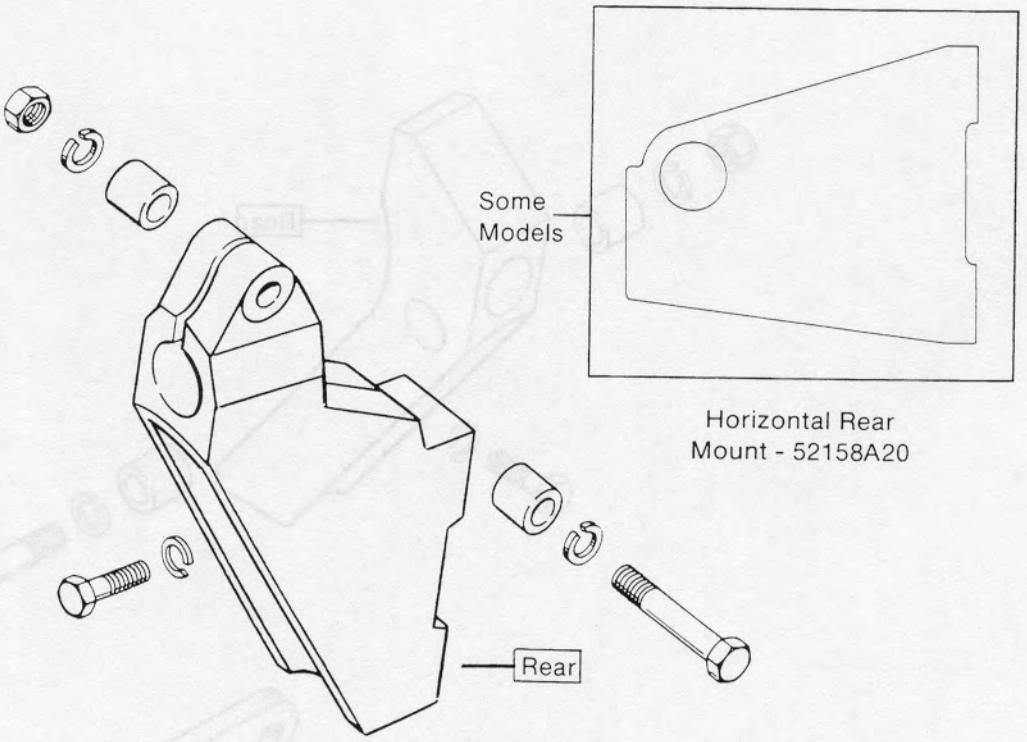
FRONT/REAR MOUNTS - MIE 228/230/255/260 In-Line Transmission Engines



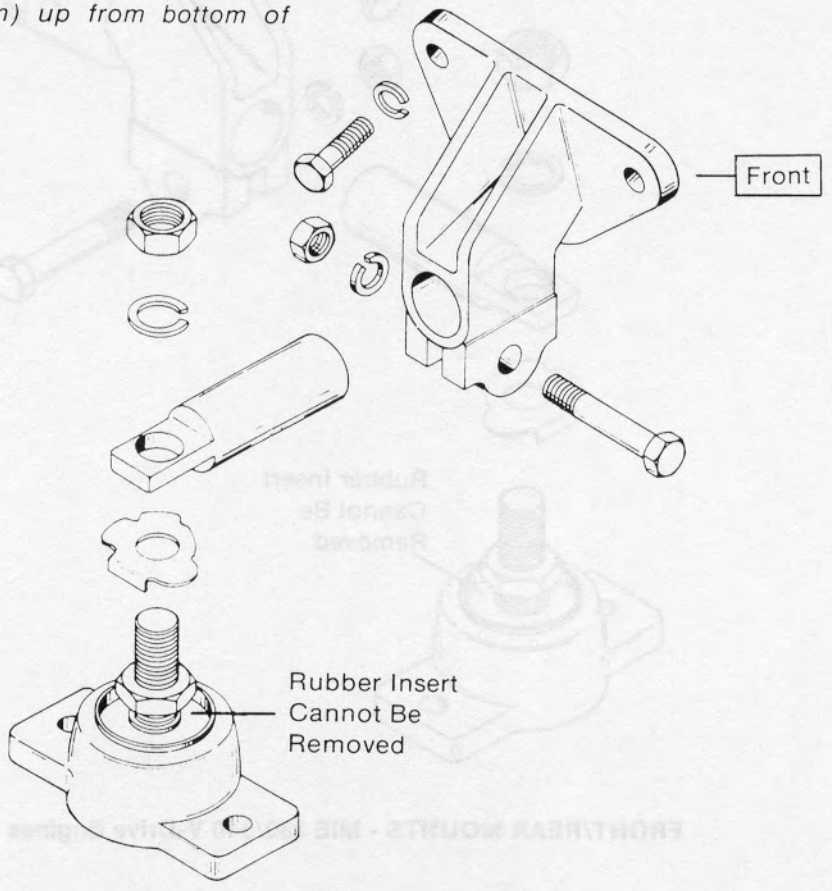
FRONT/REAR MOUNTS - MIE 228/230/255/260 V-Drive Engines



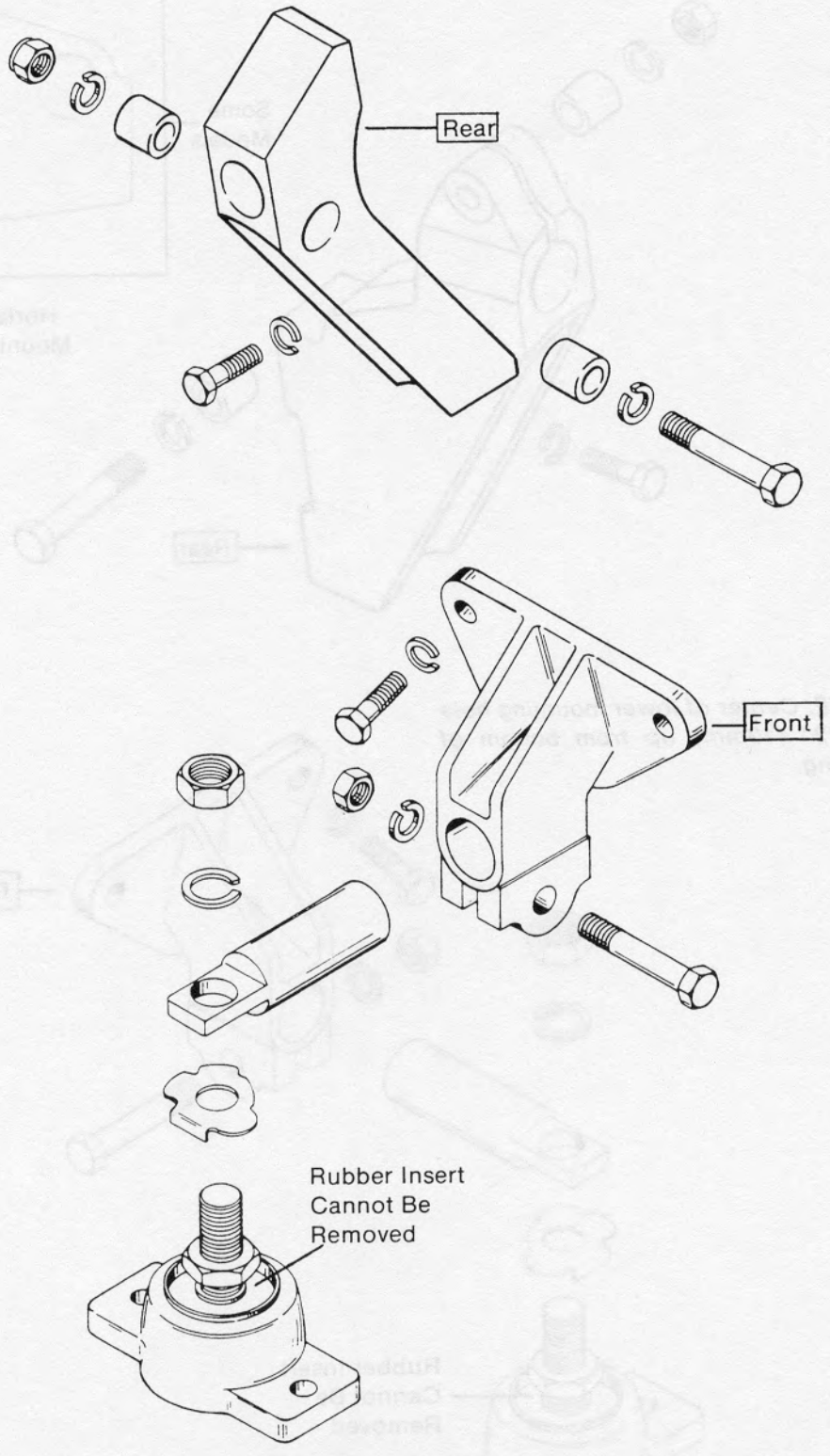
FLYWHEEL HOUSING - MIE 228/230/255/260 Engines



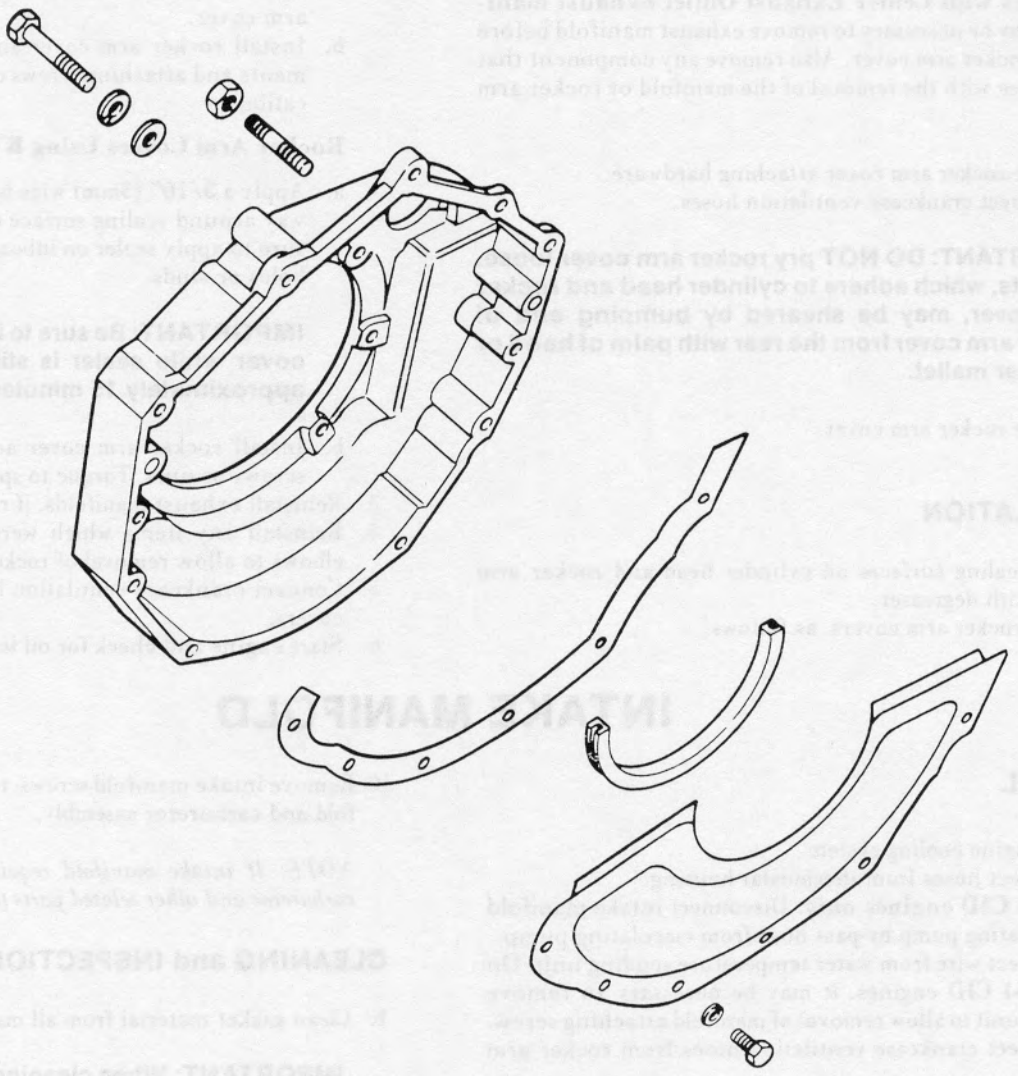
NOTE: Center of lower mounting hole is 1/2" (13mm) up from bottom of casting.



FRONT/REAR MOUNTS - MIE 330/340 In-Line Transmission Engines



FRONT/REAR MOUNTS - MIE 330/340 V-Drive Engines



FLYWHEEL HOUSING - MIE 330/340 Engines

ROCKER ARM COVER

REMOVAL

On engines with Center Exhaust Outlet exhaust manifolds: It may be necessary to remove exhaust manifold before removing rocker arm cover. Also remove any component that will interfere with the removal of the manifold or rocker arm cover.

1. Remove rocker arm cover attaching hardware.
2. Disconnect crankcase ventilation hoses.

IMPORTANT: DO NOT pry rocker arm cover loose. Gaskets, which adhere to cylinder head and rocker arm cover, may be sheared by bumping end of rocker arm cover from the rear with palm of hand or a rubber mallet.

3. Remove rocker arm cover.

INSTALLATION

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Install rocker arm covers, as follows:

Rocker Arm Covers Using Gaskets:

a. Place new rocker arm cover gasket in position in rocker arm cover.
b. Install rocker arm cover and secure with reinforcements and attaching screws or nuts. Torque to specifications.

Rocker Arm Covers Using RTV Sealer:

a. Apply a 3/16" (5mm) wide bead of RTV Sealer all-the-way around sealing surface on cylinder head, making sure to apply sealer on inboard side of attaching screw holes or studs.

IMPORTANT: Be sure to install valve rocker arm cover while sealer is still wet. Sealer dries in approximately 15 minutes.

b. Install rocker arm cover and secure with attaching screws or nuts. Torque to specifications.

3. Reinstall exhaust manifolds, if removed.
4. Reinstall any items which were removed from exhaust elbows to allow removal of rocker arm covers.
5. Connect crankcase ventilation hoses to valve rocker arm covers.
6. Start engine and check for oil leaks.

INTAKE MANIFOLD

REMOVAL

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.
   On 454 CID engines only: Disconnect intake manifold to circulating pump by-pass hose from circulating pump.
3. Disconnect wire from water temperature sending unit. On some 454 CID engines, it may be necessary to remove sending unit to allow removal of manifold attaching screw.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable from carburetor. Remove fuel line running between fuel pump and carburetor. On engines with 2-barrel carburetor, also disconnect wires from electric choke.

IMPORTANT: DO NOT crank engine over after distributor has been removed.

6. Remove distributor cap and mark position of rotor on distributor housing. Also, mark position of distributor housing on intake manifold. Remove distributor.
7. Remove other ignition components.
8. **On 305 and 350 CID engines only:** Disconnect wire from oil pressure sending unit and remove sending unit.
9. Disconnect any other items that will prevent removal of manifold.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

10. Remove intake manifold screws, then remove intake manifold and carburetor assembly.

NOTE: If intake manifold requires replacement, transfer carburetor and other related parts to new manifold.

CLEANING and INSPECTION

1. Clean gasket material from all mating surfaces.

IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase.

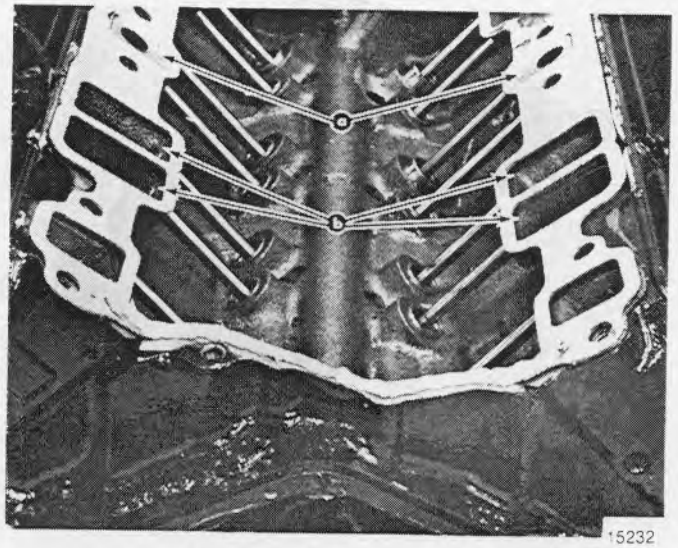
2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks, or deep scratches or leaks may result.
3. Check intake passages for varnish buildup or other foreign material. Clean as necessary.

INSTALLATION

IMPORTANT: When installing intake manifold gaskets, in next step, be sure to do the following:

- **On 305 and 350 CID engines: Be sure to install gasket with marked side up. Both gaskets are identical.**

- **On 305 CID engines with 2 barrel carburetor:** Remove metal insert from manifold gasket to be used on starboard (right) cylinder head to provide clearance for heat pipe on intake manifold.
- **On 454 CID engines:** Be sure to install gasket marked "Right Side Only" on the starboard (right) cylinder head and unmarked gasket on the port (left) cylinder head.
- **All MerCruiser V-8 G.M. engines that have "automatic" carburetor chokes MUST USE** an intake gasket that has an opening for the exhaust crossover port in the intake manifold. (Figure 1) Without this opening the "automatic" choke WILL NOT OPERATE properly. The choke will remain "ON" longer causing rough engine operation and wasted fuel.

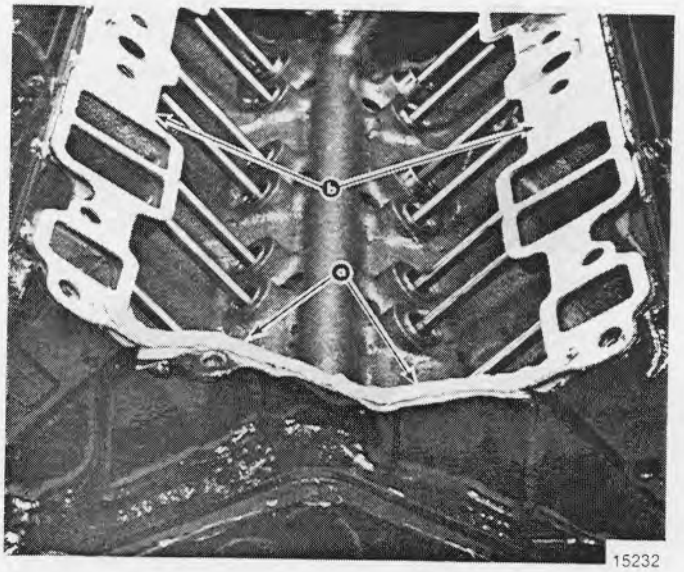


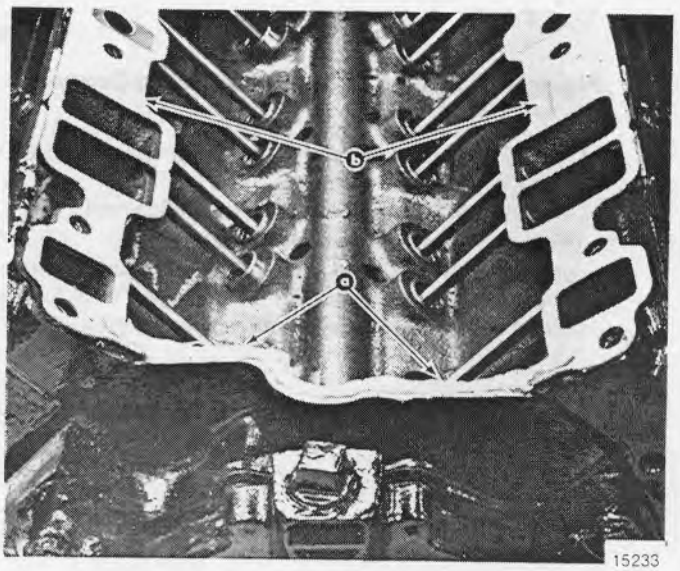
a - Exhaust Crossover Port Opening in Gasket
b - Intake Ports

Figure 1.

1. Apply Perfect Seal to intake manifold gaskets and install gaskets on cylinder heads. Install front and rear end seals on cylinder block and apply Perfect Seal to areas where seals butt against gaskets.

IMPORTANT: If cylinder block rails do not have holes for locating pins on end seals, RTV Sealer MUST BE used instead of seals. Place a 3/16" (5mm) wide bead of RTV Sealer. Extend the bead ½" (13mm) up each gasket to seal and retain gaskets. (Figure 2) RTV Sealer can be used instead of end seals on all engines, if desired.

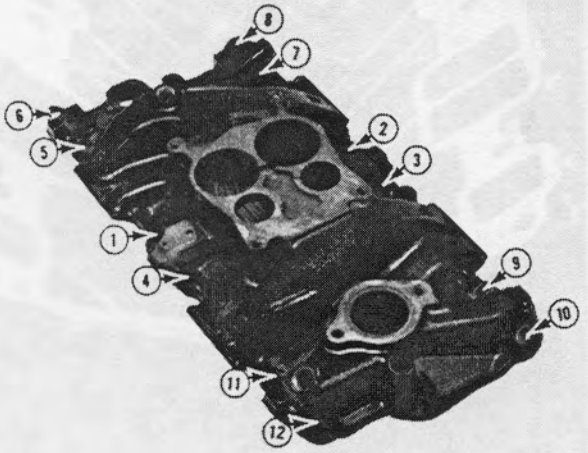




a - RTV Sealer b - Intake Manifold Gaskets

Figure 2.

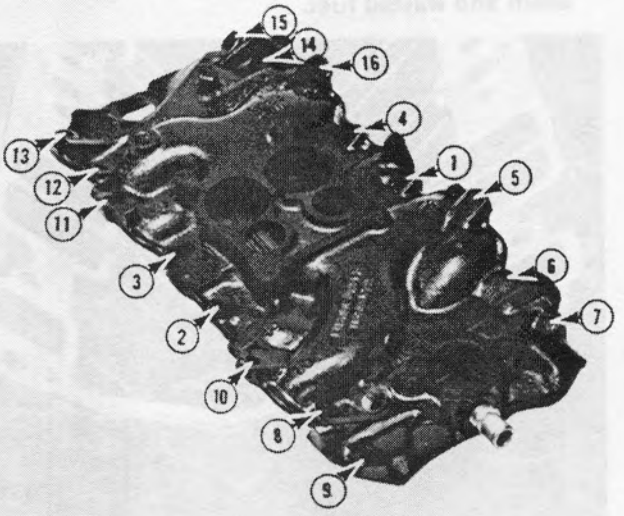
2. Carefully install manifold assembly and torque bolts to specifications in sequence outlined in Figure 3 or 4.



14396

Figure 3. 305/350 CID Manifold Torque Sequence

3. **On 454 CID engines only:** Connect intake manifold to circulating pump by-pass hose.
4. Connect wire to water temperature sending unit.
5. Reconnect hoses to thermostat housing.
6. Install fuel line to carburetor and fuel pump. Connect throttle cable to carburetor. On engines with 2-barrel carburetor, also reconnect wires to electric choke.
7. Connect crankcase ventilation hoses to rocker arm covers.
8. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
9. Install other ignition components and reconnect wires.
10. **On 305 and 350 CID engines only:** Coat threads of oil pressure sending unit with Perfect Seal and install. Connect wire to sending unit.
11. Reconnect any other items which were disconnected from manifold during the removal.
12. Start engine. Adjust ignition timing and carburetor. Check hose connections, gaskets and seals for leaks.
13. Inspect fuel line connections for fuel leaks.



14397

Figure 4. 454 CID Manifold Torque Sequence

ROCKER ARM/PUSH ROD

REMOVAL

1. Remove rocker arm covers.
2. Remove rocker arm components, rocker arms and push rods.

IMPORTANT: Place rocker arms, rocker arm components and push rods in a rack for reinstallation in the same locations.

CLEANING and INSPECTION

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

INSTALLATION

305 CID, 350 CID and 454 CID (Without Roller Rocker Arms) Engines:

IMPORTANT: Push rods with a hardened tip end MUST BE installed with the hardened tip toward rocker arm. Push rods without hardened tip MUST BE installed with large oil hole end toward rocker arms. Hardened tip end or large hole end is marked with a blue stripe.

IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rock arm balls with engine oil.

1. Install push rods. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.
3. Valve lash can be adjusted either with engine stopped or running.

454 CID (With Roller Rocker Arms) Engines:

IMPORTANT: No. 1 and No. 8 intake rocker arm have 3/16" (5mm) removed from left hand corner of arm to clear valve cover. If new rocker arm is used, modify as shown in Figure 1.

IMPORTANT: When installing rocker arms and push rods, lubricate with engine oil.

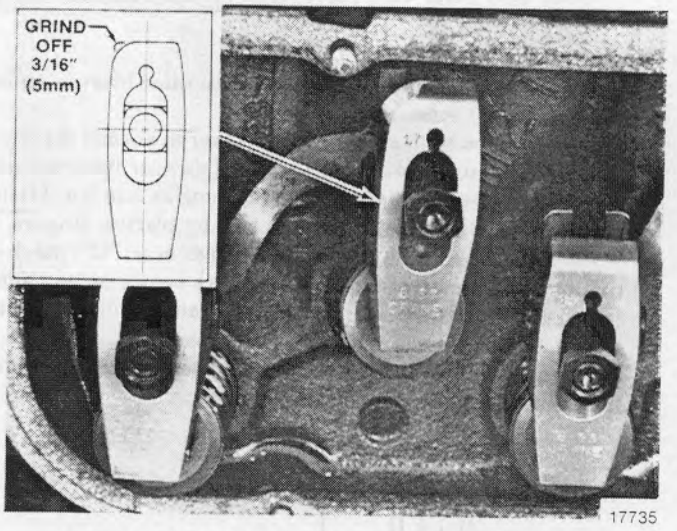


Figure 1. No. 1 and No. 8 Intake Rocker Arm

1. Install push rods (long-exhaust, short-intake). Be sure push rods seat in lifter socket.
2. Install new rocker arms making sure that flat side of pivot shaft is facing up. (Figure 2) Lubricate ends of rocker arm studs and valve stem ends with Needle Bearing Lubricant (92-42649A1). Install locking nuts on studs.
3. Valve adjustment must be done with engine stopped.

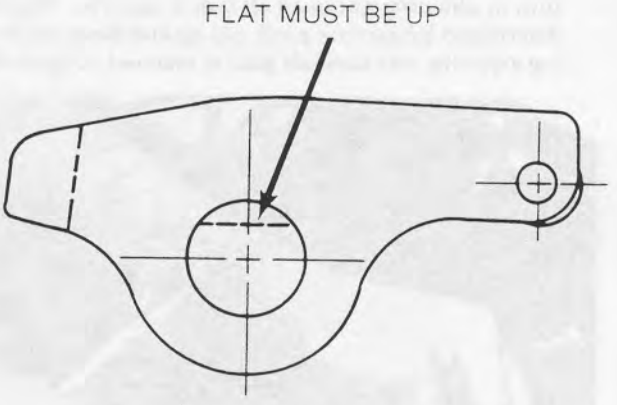


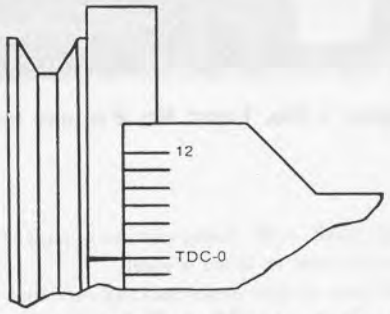
Figure 2.

ADJUSTMENT - ENGINE STOPPED

305, 350 and 454 (without Roller Rocker Arm) CID Engines:

With valve cover removed, adjust valves when lifter is on low part of camshaft lobe, as follows:

1. Crank engine with starter or turn over in normal direction of rotation until mark on torsional damper lines up with center "O" mark on timing tab, and engine is in No. 1 firing position. This may be determined by placing fingers on No. 1 valve as mark on damper comes near "O" mark on timing mark. If valves move as mark comes up to timing tab, engine is in No. 6 firing position and should be turned over one more time to reach No. 1 position.
2. With engine in No. 1 firing position, as determined above, the following valves may be adjusted.



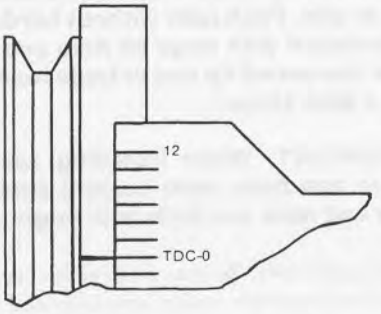
3. **MCM and MIE Left Hand (Standard) Rotation Engines:**
   Exhaust - 1-3-4-8 Intake - 1-2-5-7
   MIE Right Hand (Opposite) Rotation Engines:
   Exhaust - 1-2-5-7 Intake - 1-3-4-8
4. Back out adjusting nut until lash is felt at push rod, then turn in adjusting nut until all lash is removed. This can be determined by moving push rod up-and-down while turning adjusting nut until all play is removed. (Figure 3)

5. Hydraulic lifters now can be adjusted by tightening adjustment nut an additional 1-turn. No other adjustment is required.
6. Crank engine one revolution until pointer "O" mark and torsional damper mark are again in alignment. This is No. 6 firing position. With engine in this position, the following valves may be adjusted as previously outlined.
7. **MCM and MIE Left Hand (Standard) Rotation Engines:**
   Exhaust - 2-5-6-7 Intake - 3-4-6-8
   MIE Right Hand (Opposite) Rotation Engines:
   Exhaust - 3-4-6-8 Intake - 2-5-6-7

454 (with Roller Rocker Arms) CID Engines:

Valves must be adjusted when hydraulic lifter is on low part of camshaft.

1. Rotate engine (in normal direction of rotation) until timing mark on crankshaft balancer lines up with "0" (TDC) mark on timing tab and engine is in No. 1 firing position. This may be determined by placing fingers on No. 1 push rods as mark on balancer comes near the "0" (TDC) mark. If push rods move as timing mark comes up on "0", engine is in No. 6 firing position. Rotate crankshaft one more complete revolution to reach No. 1 firing position.



2. With engine crankshaft positioned as outlined, adjust valves on the following cylinders:

   Exhaust - 1-3-4-8 Intake - 1-2-5-7

IMPORTANT: Make sure push rods are centered in sockets of rocker arm BEFORE tightening. This must be done for each valve.

Figure 3. Valve Adjustment

3. To obtain correct valve lash, turn 9/16" locking nut down on rocker arm until there is zero clearance between rocker arm and valve stem. Turn locking nut an additional ½ turn and snug allen screw onto top of rocker arm stud. DO NOT let locking nut turn. Remove allen wrench and box wrench and torque locking nut to 30 lbs. ft. (41 N.m). (Figure 4)

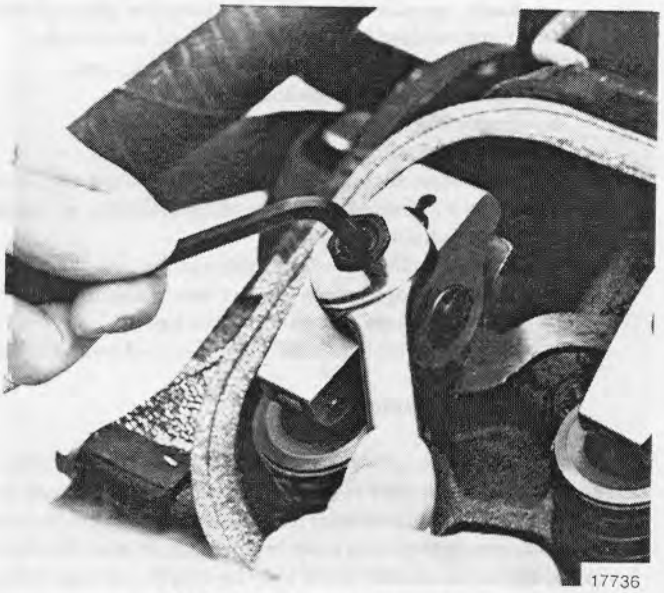


Figure 4. Valve Adjustment

4. Rotate crankshaft one complete (360°) revolution until timing mark on balancer is aligned with "O" mark on timing tab. Adjust valves on the following cylinders:

Exhaust - 2-5-6-7 Intake - 3-4-6-8

5. Adjust remaining rocker arms as outlined in Step 3.

ADJUSTMENT - ENGINE RUNNING

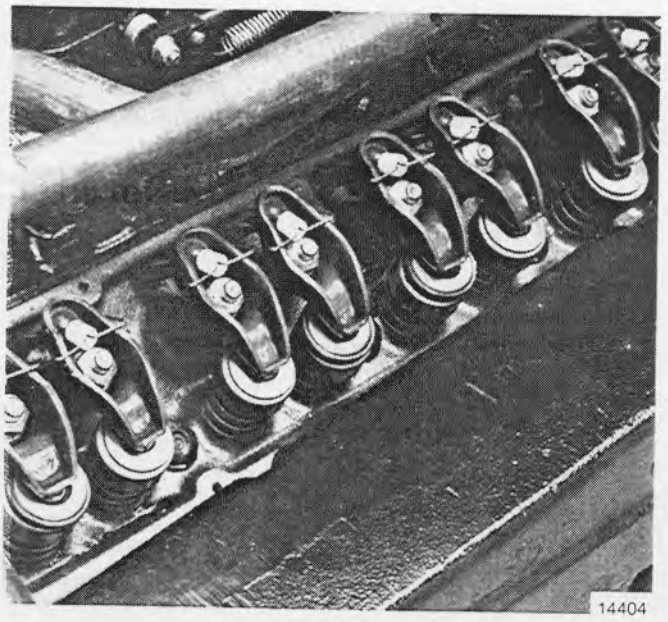


Figure 5. Rocker Stoppers 91-66273

305, 350 and 454 (without Roller Rocker Arms) CID Engines:

Following procedure is performed with engine running:

1. After engine has reached normal operating temperature, remove valve covers and install rocker stoppers. (Figure 5)
2. With engine running at idle, back rocker arm nuts off (one at a time) until valve rocker arm starts to clatter. (Figure 6)
3. Turn rocker arm nut down until clatter just stops. This is
4. Turn nut down ¼ additional turn and pause 10 seconds until engine runs smoothly. Repeat until nut has been turned down 1-turn from the zero lash position.

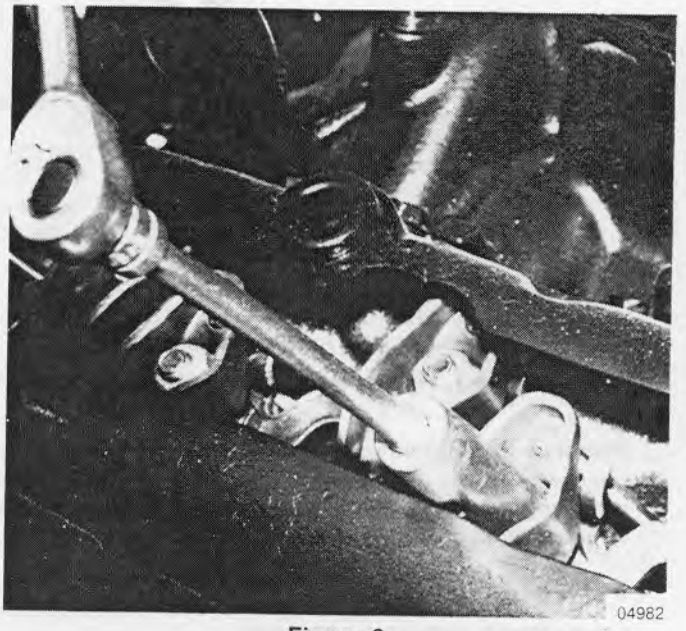
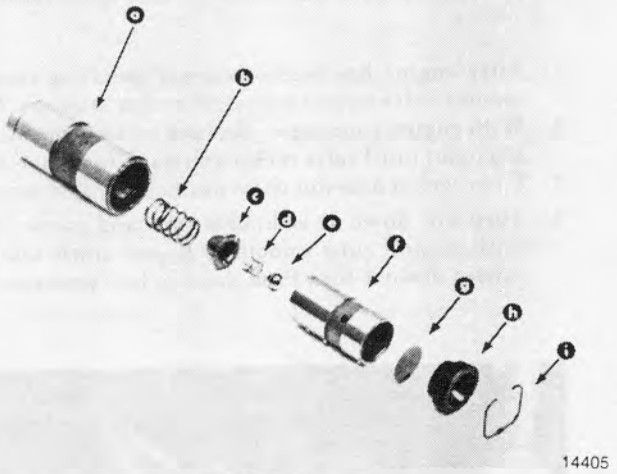


Figure 6.

IMPORTANT: This 1-turn preload adjustment must be done slowly to allow lifter to adjust itself, thus preventing possibility of interference between inlet valve head and top of piston which might result in internal damage and/or bent push rods.

5. Repeat Steps 2-3-4 to adjust other valves.
6. Remove rocker stoppers after all valves are adjusted.
7. After valves have been adjusted, complete the following:
   a. Install new gaskest (or RTV), and install covers. Torque to specifications.
   b. Adjust carburetor idle speed and mixture.
   c. Start engine and check for leaks.

HYDRAULIC VALVE LIFTERS



a - Lifter Body
b - Plunger Spring
c - Check Ball Retainer
d - Check Ball Spring
e - Check Ball
f - Plunger
g - Metering Valve
h - Push Rod Seat
i - Push Rod Seat Retainer

Figure 1. Hydraulic Valve Lifter Assembly

Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

LOCATING NOISY LIFTERS

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise -- Usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or "pick-up" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise -- Probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train -- This will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking -- Probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc, is shown to exist in one unit, it more likely exists in all the units, thus it would only be a matter of time before all lifters caused trouble.

REMOVAL

1. Remove intake manifold.
2. Remove valve mechanism.
3. Remove valve lifters.

IMPORTANT: Keep push rod and hydraulic valve lifter from each valve together as a matched set and mark them so they can be reinstalled in the same location later.

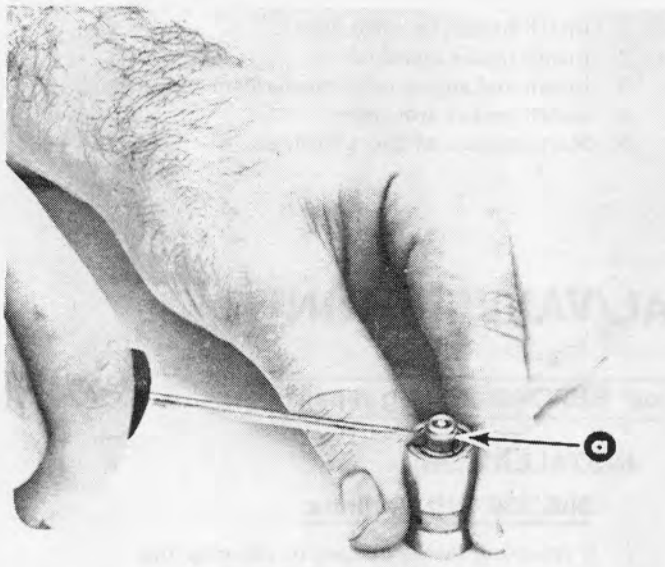
DISASSEMBLY

NOTE: Refer to Figure 1, for parts identification.

IMPORTANT: The internal parts of each hydraulic lifter assembly are matched sets. DO NOT INTERMIX the PARTS.

1. Hold plunger down with a push rod and remove push rod seat retainer with the blade of a small screwdriver.
2. Remove push rod seat and metering valve.

3. Remove the plunger, ball check valve assembly and the plunger spring.
4. Remove the ball check valve and spring by prying the ball retainer loose from the plunger with the blade of a small screwdriver. (Figure 2)



14406

a - Check Ball Retainer

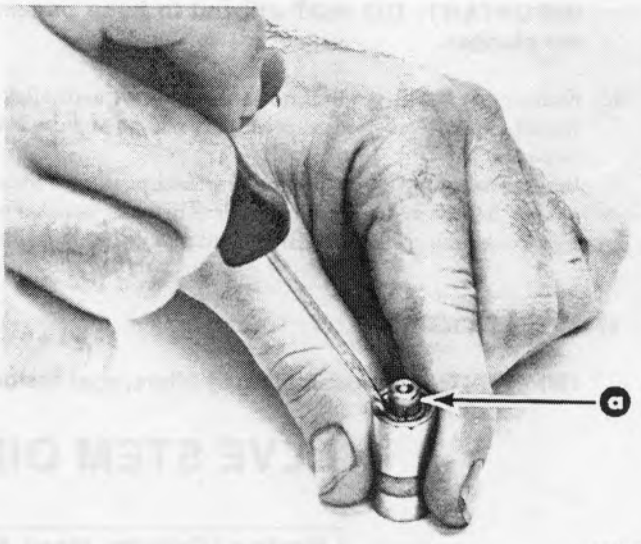
Figure 2. Removing Ball Check Valve

CLEANING and INSPECTION

Thoroughly clean all parts in cleaning solvent and inspect them carefully. If any parts are damaged or worn, entire lifter assembly should be replaced. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is scuffed or worn, inspect camshaft lobe. If push rod seat is scuffed or worn, inspect push rod.

REASSEMBLY

1. Place the check ball in small hole in bottom of the plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on the ball. Carefully press the retainer into position in plunger with the blade of a small screwdriver. (Figure 3)

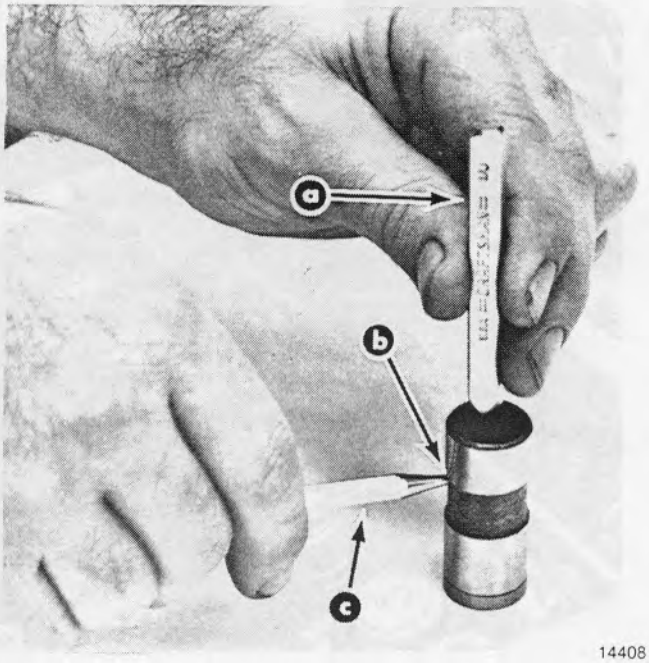


14407

a - Check Ball Retainer

Figure 3. Installing Check Ball Valve

3. Place the plunger spring over the ball retainer and slide the lifter body over the spring and plunger, being careful to line up the oil feed hole in the lifter body and plunger.
4. Fill the assembly with oil, then insert the end of a ⅛" drift pin into the plunger and press down on check ball until hole in lifter body aligns with hole in plunger.
5. Insert a 1/16" drift pin through both oil holes to hold the plunger down against the lifter spring tension. (Figure 4)



14408

a - 1/8" Drift Pin
b - Oil Feed Hole
c - 1/16" Drift Pin

Figure 4. Oil Feed Holes Aligned and Drift Pin Installed

IMPORTANT: DO NOT attempt to force or pump the plunger.

6. Remove the ⅛" drift pin and refill assembly with oil.
7. Install the metering valve, push rod seat and push rod seat retainer.
8. Press down on the push rod seat with a push rod and remove 1/16" drift pin from lifter. The lifter is now completely assembled, filled with oil and ready for installation.

INSTALLATION

IMPORTANT: Before installing lifters, coat the bottom of the lifter with engine oil. If new lifters or a new camshaft has been installed, an additive containing EP lube (such as Quicksilver 4-Cycle Super Engine Oil Supplement) should be poured over camshaft lobes before installing lifters.

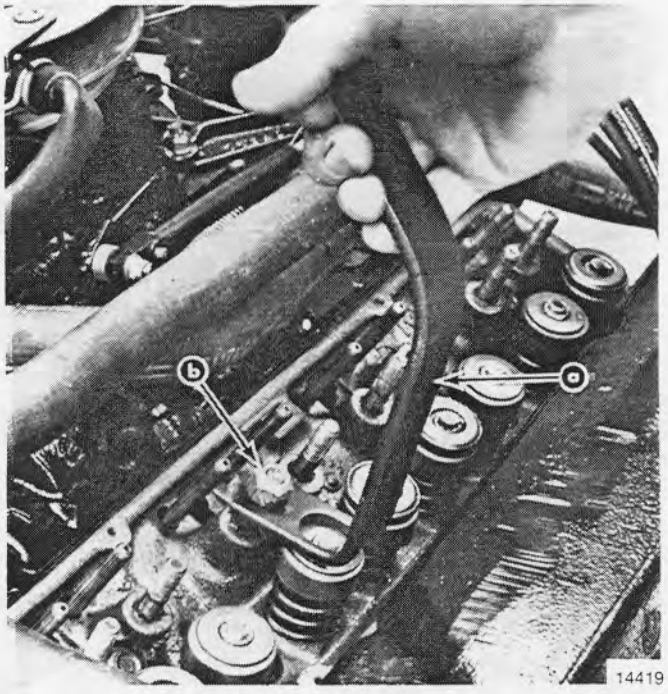
1. Install hydraulic valve lifters.
2. Install intake manifold.
3. Install and adjust valve mechanism as outlined.
4. Install rocker arm cover.
5. Start engine and check for leaks.

VALVE STEM OIL SEAL/VALVE SPRING

Review "Cylinder Head Assemblies" BEFORE starting repair.

REMOVAL

1. Remove rocker arm cover.
2. Remove spark plug, rocker arm and push rod on cylinder(s) to be serviced.
3. Position piston (in cylinder to be serviced) at TDC, to prevent valve from dropping out of valve guide.
4. Compress valve spring with J-5892 Tool. Remove valve locks and all other components. (Figure 1)



a - J-5892 Tool b - Rocker Arm Nut

Figure 1. Compressing Valve Spring

5. Remove valve stem oil seal(s) from valve (except later style 454 cu. in. hi-performance engines).

NOTE: On later style 454 CID hi-performance engines, valve stem oil seal is part of valve cap. If oil seal requires replacement, entire valve cap and seal assembly MUST BE replaced.

INSTALLATION

305/350 CID Engines:

1. If removed, install damper in valve spring.
2. If engine has additional valve stem seal:
   a. Install intake valve seal.
   b. DO NOT install exhaust valve seal, discard.
3. Set valve spring, damper, valve shield and cap in place. Be sure to install valve cap with rotator on exhaust valve. Compress spring with Tool J-5892 and install oil seal into lower groove of valve stem.

NOTE: A light film of oil will help prevent twisting of the seal.

4. Install valve locks and release pressure of tool, being sure that locks are in place. Grease may be used to help hold locks while removing pressure from tool.

454 CID Engine - Standard and Earlier Style Hi-Performance:

1. Install valve rotator or shim in position on valve spring seat. (Rotator is used on exhaust valve; shim is used on intake valve.)
2. Coat valve stem oil seal with engine oil and install over valve stem.

IMPORTANT: If new pressed-on type intake valve stem oil seals are to be used, install seals in accordance with instructions which accompany them.

3. If removed, install damper in valve spring.
4. Set valve spring and damper assembly and valve spring cap in position over valve stem.
5. Compress spring with J-5892 tool and install valve locks. Then release compressor tool, making sure that locks seat properly in groove of valve stem.

NOTE: Grease may be used to hold locks in place while releasing compressor tool.

IMPORTANT: Compress valve spring only enough to install valve locks in next step. Excess compression could cause valve spring cap to damage seal.

454 CID Engines - Later Style Hi-Performance:

1. Make sure that shim is in position on valve spring seat.
2. Set valve springs and damper assembly and valve spring cap and oil seal assembly in position over valve stem.
3. Compress spring with J-5892 tool and install valve locks. Then release compressor tool, making sure that locks seat properly in groove of valve stem.

NOTE: Grease may be used to hold locks in place while releasing compressor tool.

IMPORTANT: Compress valve spring only enough to install valve locks in next step. Excess compression could cause damage to seal.

305/350/454 CID Engines:

1. Install spark plug(s) and torque to specifications.
2. Install and adjust valve mechanism.
3. Install rocker arm cover and torque to specifications.
4. Start engine and check for leaks.

CYLINDER HEAD ASSEMBLIES

REPLACEMENT PART INFORMATION - 305/350 CID ENGINES

IMPORTANT: Be sure to read this information before performing any repairs on cylinder head, exhaust valve springs and/or exhaust valve.

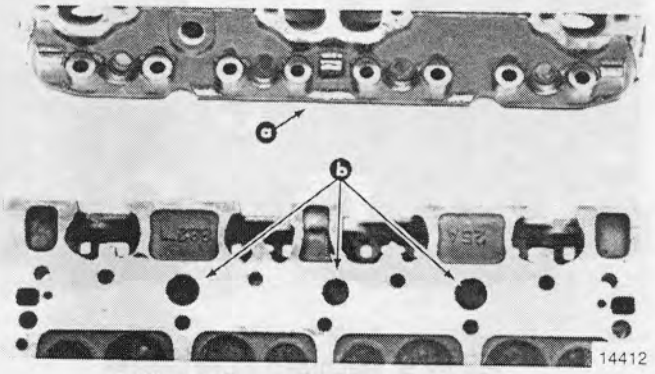
Three different types of cylinder heads are in use on MerCruiser 305 and 350 CID Engines: (1) The heavy head, (2) the lightweight - 1st design head and (3) the lightweight - 2nd design head.

The new lightweight cylinder heads were released for 1978 production 305 and 350 CID engines. These new heads are approximately 6 pounds lighter than the earlier style heavy heads.

The lightweight heads were used together with the earlier style heavy heads for a period of time, because of production requirements and limited machining capacities at the manufacturer's casting and machining plants. Therefore, engines may be assembled with either heavy or lightweight heads or one of each type.

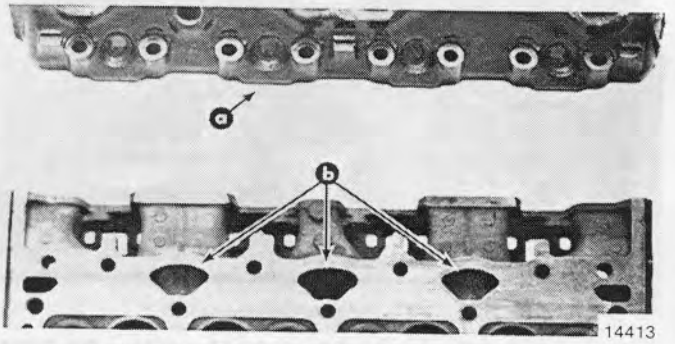
Heavy and Lightweight Head Identification:

To determine if a head is a heavy head or a lightweight head, refer to Figures 1 and 2.



a - Straight Bottom Surface Design Contour
b - Round Water Passage Holes

Figure 1. Heavy Head Identification



a - Irregular Bottom Surface Design Contour
b - Fan-Shaped Water Passage Holes

Figure 2. Lightweight Head Identification

Lightweight Head - 1st Design:

Exhaust valve spring seats are machined to "heavy" head specifications (uses 24-48347 valve spring assembly for intake valve and 24-72642 valve spring assembly for exhaust valve).

Lightweight Head - 2nd Design:

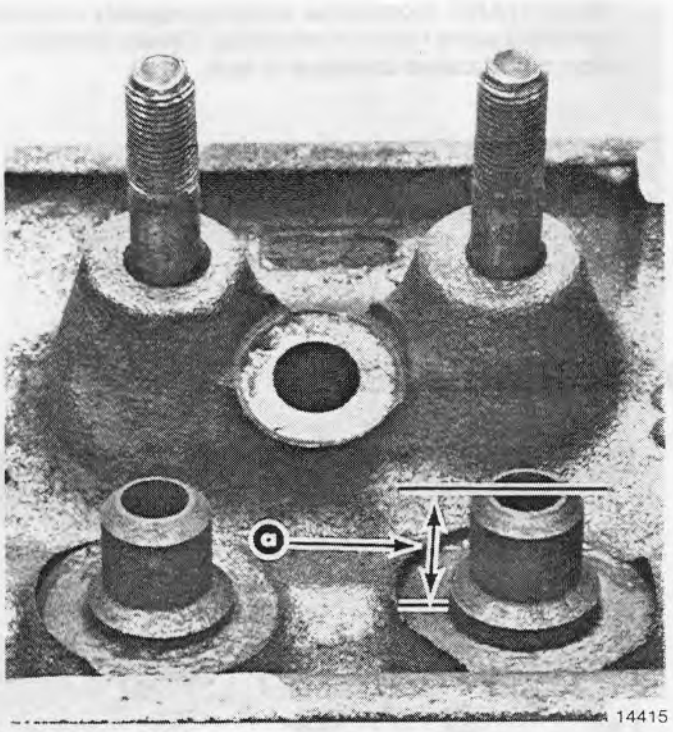
Incorporates machining that allows intake valve spring assembly (24-48347) to be used at both intake and exhaust valve locations.

The valve springs can be identified by paint stripes and measurements, as follows:

- 24-48347 - Intake Spring: (one lavender stripe) approx. 2.03" [2-1/32" (51.5mm)] free height
- 24-72642 - Exhaust Spring: (2 light green stripes) approx. 1.91" [1-29/32" (48.5mm)] free height

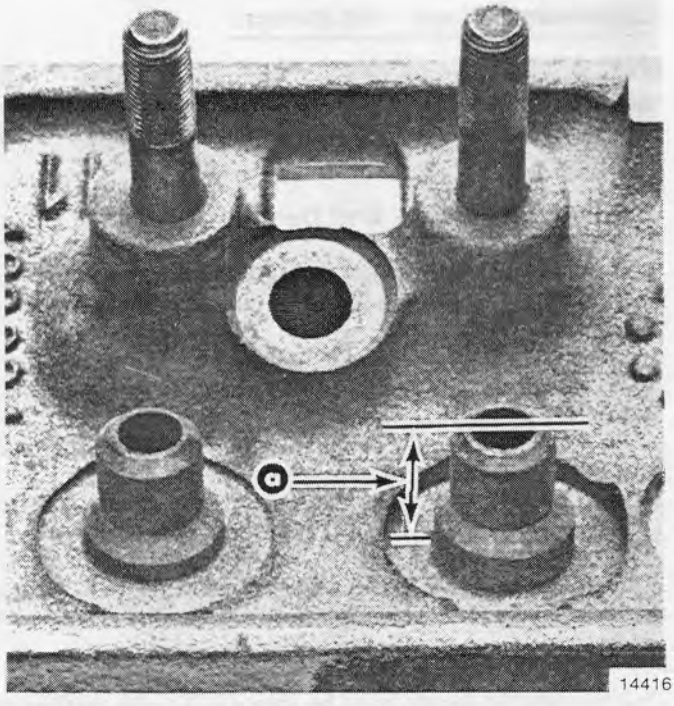
The cylinder heads can be identified by measuring from the top of the exhaust valve guide to valve spring seat. (Figures 3 and 4)

Service cylinder heads must be identified by this method to ensure correct valve spring usage prior to installation.



a - .75" [3/4" (19mm)]

Figure 3. 1st Design Lightweight Head, Use 24-72642 Valve Spring



a - .84" [27/32" (21mm)]

Figure 4. 2nd Design Lightweight Head, Use 24-48347 Valve Spring

Exhaust Valve Stem Diameter/Guide Bore:

All early style "heavy" cylinder heads have exhaust valve guide bores machined to accept .341" (8.661mm) exhaust valve stems. (Exhaust valve 35323).

Late style "lightweight" cylinder heads were manufactured with both .341" (8.661mm) and .372" (9.449mm) exhaust valve stem diameters.

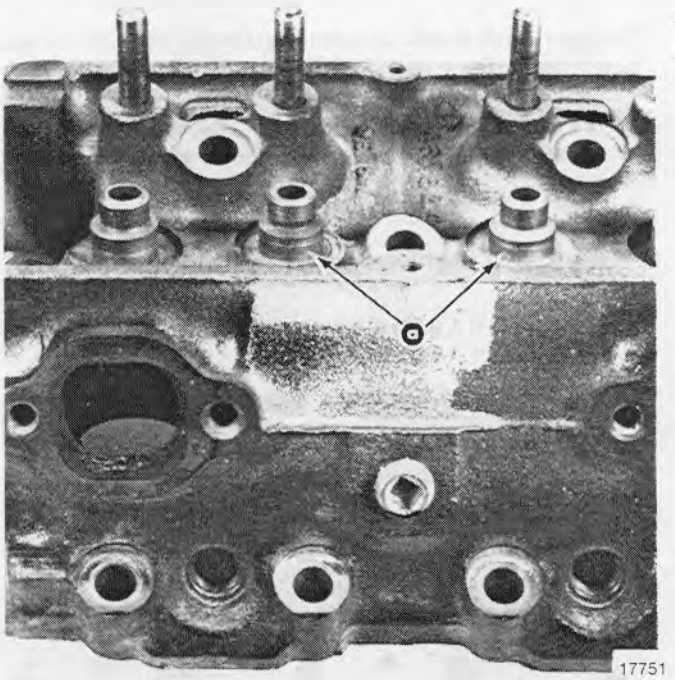
MCM 898 models with "lightweight" cylinder heads use exhaust valves with .341" (8.661mm) stem diameter (85803).

MCM/MIE 228, MIE 255 and MCM 260 models with "lightweight" cylinder heads normally use exhaust valves with .372" (9.449mm) stem diameter (87284); HOWEVER, there have been instances where small diameter .341" (8.661mm) exhaust valve (85803) stems and guide bores have been found in these models. It is imperative, therefore, that precise measurements of exhaust valve stem/guide dimensions be taken when ordering replacement exhaust valves for these models.

Cylinder Heads with Valve Guide Seal:

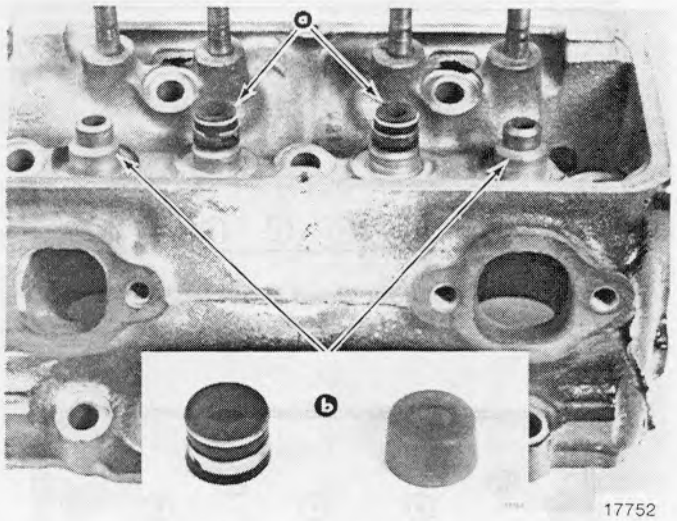
Later production, lightweight heads - 2nd design: With valve guide seals, refer to Figures 5 and 6.

IMPORTANT: DO NOT use exhaust valve guide seals. If engine has seal, remove and discard during repair.



a - Valve Guides

Figure 5. Machined Valve Guides



a - Intake Valve Guide Seals
b - Exhaust Valve Guide Seals - Discard

Figure 6. Valve Guide Seals

Replacement Cylinder Heads:

When ordering replacement cylinder heads, determine if early style "heavy" or late style "lightweight" cylinder heads are required, then order from the following chart:

MODEL	"HEAVY"	"LIGHTWEIGHT"
MCM 898	938-6536	938-7482
MCM/MIE 228	938-6536	938-7482
MCM 260/MIE 255	938-4625	938-7499
MCM 898R/228R/ 260R	Refer to Parts Manual	
MIE 230/260	Refer to Parts Manual	

All "lightweight" service replacement cylinder heads are 2nd design configuration; therefore, if a replacement cylinder head is required for an engine, that is originally equipped with a 1st design "lightweight" cylinder head, new exhaust valve springs (24-48347) also must be installed (4 required per cylinder head).

In addition, all "lightweight" service replacement cylinder heads use exhaust valves with .372" (9.449mm) stem diameter. Because of this, when installing a replacement "lightweight" cylinder head on a MCM 898, new exhaust valves (87284) also must be installed.

Any model MerCruiser V-8 engine, which was originally equipped with an early style "heavy" cylinder head, can be converted to late style "lightweight" cylinder head only if the proper exhaust valves and exhaust valve springs also are installed.

CYLINDER HEAD

Review "Cylinder Head Assemblies" BEFORE Starting Repair

REMOVAL

1. Drain engine cooling system.
2. Remove exhaust manifolds.
3. Remove intake manifold.
4. Remove valve mechanism.

NOTE: Remove any component attached to front or aft end of cylinder head to be removed.

5. Remove spark plugs.
6. Remove spark plug wire retainers from cylinder head.
7. Remove cylinder head bolts, cylinder head and gasket.
8. Place cylinder head on 2 blocks of wood to prevent damage.

CLEANING and INSPECTION

For cleaning and inspection, refer to "Cylinder Head and Valve Conditioning".

INSTALLATION

⚠CAUTION

Gasket surfaces on both head and block must be clean of any foreign matter and free of nicks or deep scratches. Cylinder bolt threads in block and threads on cylinder head bolts must be clean. (Dirt will affect bolt torque.)

1. On engines using a STAINLESS STEEL gasket, coat both sides of new gasket with Perfect Seal. Spread sealer thin and even. Too much sealer may hold gasket away from head or block.

⚠CAUTION

Use no sealer on engines which have a composition STEEL ASBESTOS gasket.

2. Place gasket in position over dowel pins.
3. Carefully guide cylinder head into place over dowel pins and gasket.
4. Coat threads of cylinder head bolts with Perfect Seal and install bolts finger-tight.
5. Tighten each cylinder head bolt a little at a time in sequence shown in torque sequence chart until specified torque is reached. (Figure 1 or 2)
6. Install exhaust manifolds as outlined.
7. Install intake manifold as described.
8. Install and adjust valve mechanism as outlined.
9. Install valve covers.
10. Install spark plugs. Torque spark plugs to specifications.
11. Install spark plug wire retainers.

NOTE: Install any component that was removed from the front or aft end of cylinder head.

12. Run engine, adjust timing and check for leaks.

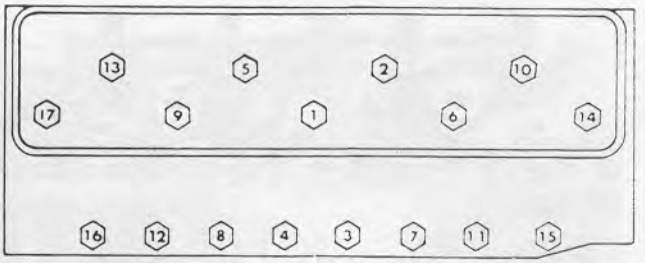


Figure 1. Cylinder Head Torque Sequence - 305/350 CID Models

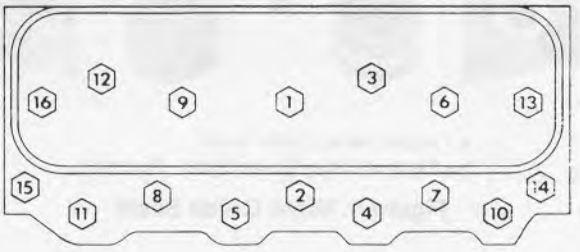


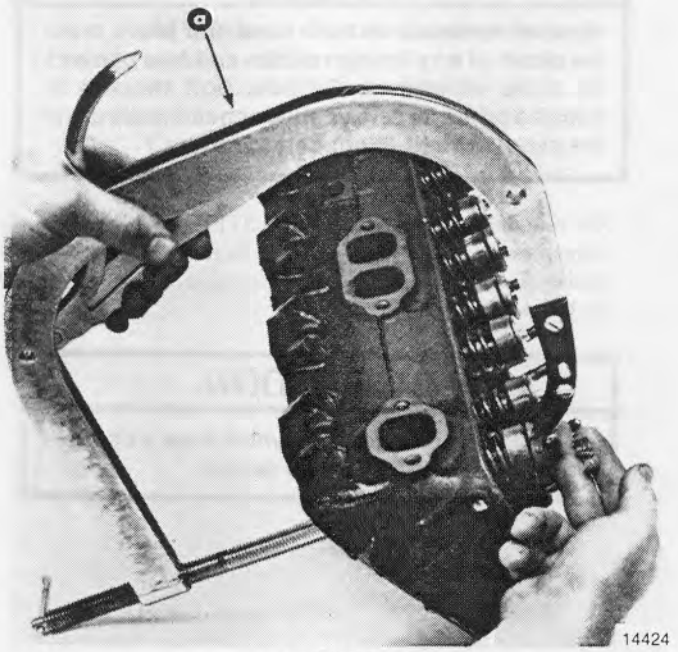
Figure 2. Cylinder Head Torque Sequence - 454 CID Models

CYLINDER HEAD and VALVE CONDITIONING

Review "Cylinder Head Assemblies" BEFORE Starting Repair.

DISASSEMBLY

1. With cylinder head removed, remove rocker arms and components (if not previously done).
2. Compress valve springs with J-8062 tool (Figure 1) and remove valve retainers. Release compressor tool and remove all valve components.
3. Remove valves from cylinder head and place valves in a rack in their proper sequence for reassembly in their original positions.

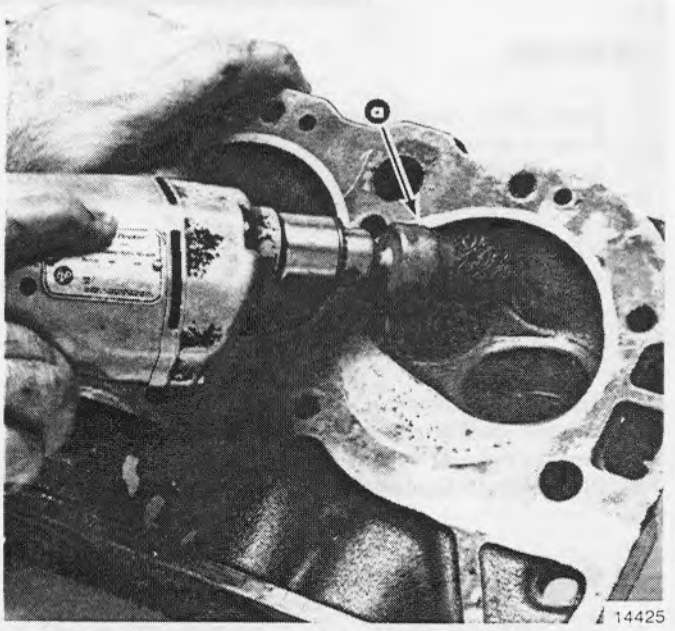


a - J-8062 Tool

Figure 1. Compressing Valve Spring

CLEANING

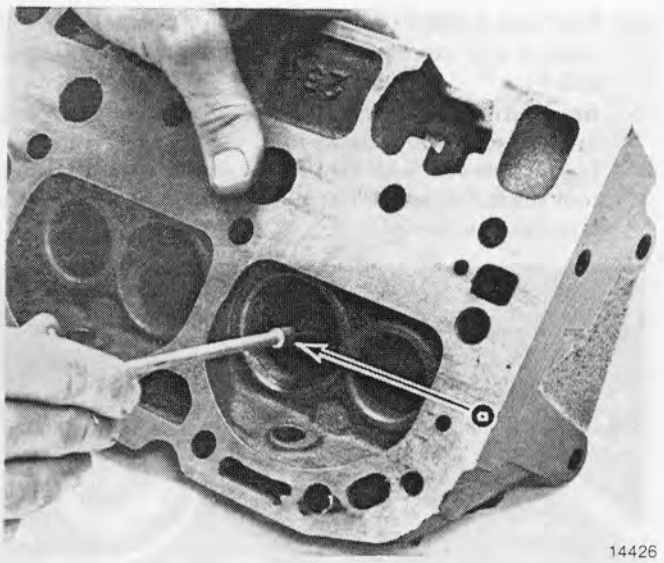
1. Clean all carbon from combustion chambers and vale ports with J-8089 tool. (Figure 2)



a - J-8089 Tool

Figure 2. Cleaning Combustion Chambers

2. Thoroughly clean valve guides with J-8101 tool. (Figure 3)
3. Clean all push rods, rocker arms and push rod guides.
4. Clean carbon from valves on a buffing wheel.
5. Clean carbon deposits and gasket material from cylinder head mating surfaces.

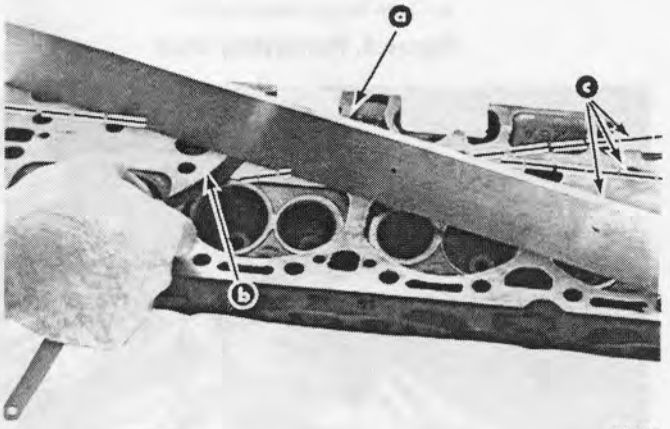


a - J-8101 Tool

Figure 3. Cleaning Valve Guides

INSPECTION

1. Inspect cylinder head for cracks in the exhaust ports, combustion chambers (especially around spark plug holes and valve seats) and for cracks in external surface of water jacket. Replace head if cracked.
2. Inspect cylinder head gasket surface for burrs, nicks, erosion or other damage. Also, check flatness of cylinder head gasket surface, using a machinists straight edge and feeler gauges as shown in Figure 4. Refer to "Specifications".



a - Straight Edge
b - Feeler Gauge
c - Take Measurements Diagonally Across Head (Both Ways) and Straight Down Center Head

Figure 4. Checking Gasket Surface of Cylinder Head for Flatness

IMPORTANT: Cylinder head to block gasket surface should be resurfaced if out-of-flat more than specified. When resurfacing gasket surface, cylinder head to intake manifold gasket surface also MUST BE milled to provide proper alignment between manifold and head.

3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky functioning of valve and disturb engine smoothness.

4. Measure valve stem clearance (Figure 5) as follows: Clamp a dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side-to-side (crosswise to the head) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide. With valve head dropped about 1/16" (2mm) off valve seat, move valve stem from side-to-side, using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves, as outlined under "Valve Guide Bore Repair".

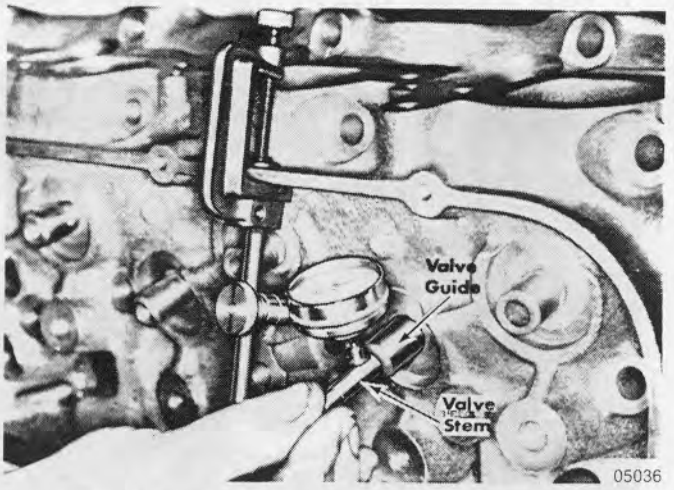


Figure 5. Measuring Valve Stem Clearance

5. Check valve spring tension with J-8056 spring tester. (Figure 6)

IMPORTANT: Springs should be compressed to specified height and checked against specification. Springs should be replaced if not within 10 lbs. ft. (13.5 N.m) of specified load.

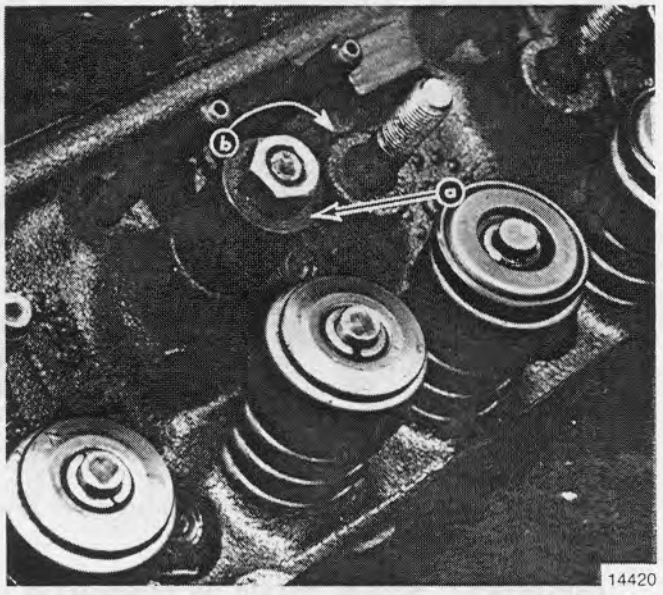
6. Inspect rocker arm studs for wear or damage. Inspect push rod guides for wear or damage.

Figure 6. Checking Valve Spring Tension

ROCKER ARM STUDS and PUSH ROD GUIDE REPAIRS

305/350 CID Models:

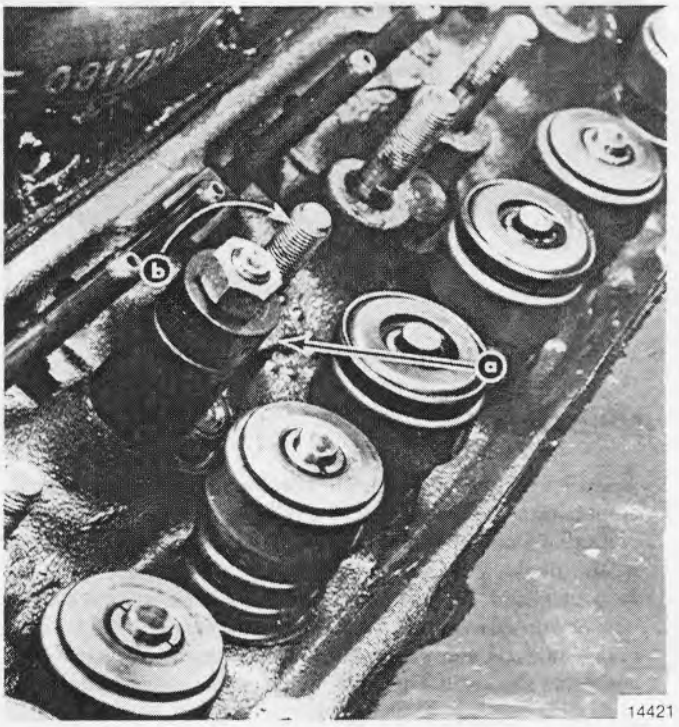
1. Rocker arm studs, which are replaced because of wear or looseness, should be replaced with oversize studs.



a - Large Sleeve
b - 3/8 x 24 Nut - Turn until Nut Bottoms Out on Stud Threads. Then Remove Nut

Figure 7. Using J-5802-01 Tool

2. Use Tool J-5802-01 to remove old stud by placing tool, flat washer and nut over stud, then turning nut. (Figures 7 and 8)
3. Ream stud hole, whenever installing an oversize stud, using appropriate reaming tool.
4. Install new stud with Tool J-6880 or similar stud installing tool made for press-in type studs. (Figure 9) Follow instructions with tool.



a - Install Small Sleeve
b - Turn Nut to Remove Stud

Figure 8. Removing Stud

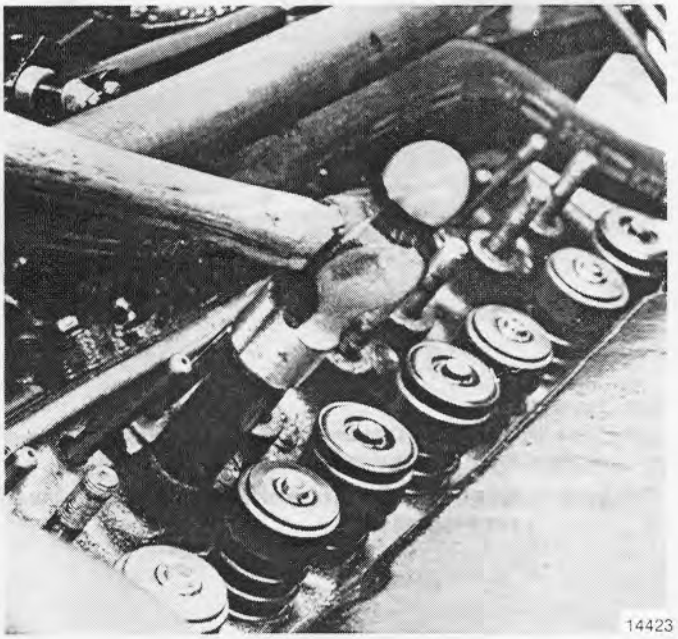


Figure 9. Installing Stud Tool J-6880

454 CID Models:

IMPORTANT: Rocker arm studs are threaded into the cylinder head. Coat threads on cylinder head end of rocker arm studs with sealer before assembling to cylinder head.

Push rod guides are attached to cylinder head by rocker arm studs. (Figure 10) Replace if worn and torque rocker arm studs to specifications.

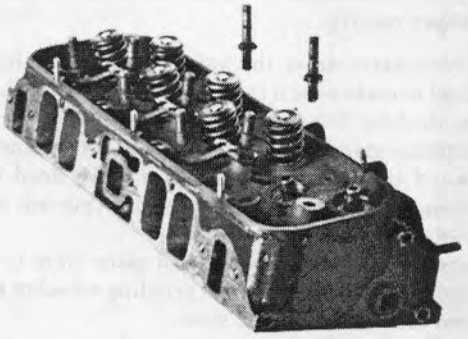


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Figure 10. 454 Cylinder Head

VALVE GUIDE BORE REPAIR

IMPORTANT: On 305 and 350 CID engines, be sure to measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015" oversize valves are required ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size Valve Guide Reamer from chart below.

Standard Valve Stem Diameter	Reamer Required for Oversize Valve
.341	J-5830-2
.372	J-7049-5

2. Ream valve guide bores, as shown in Figure 11.
3. Remove the sharp corner created by reamer at top of valve guide.

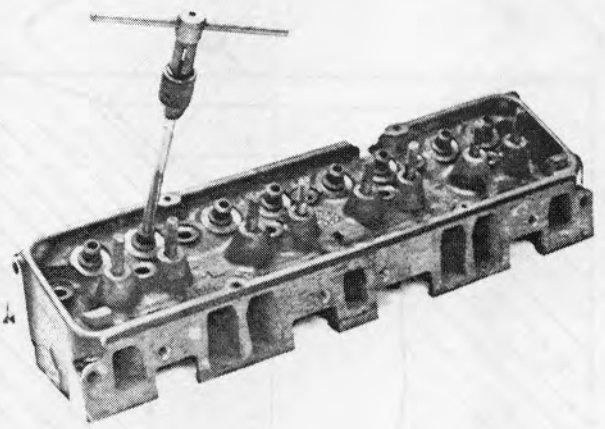

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Figure 11. Reaming Valve Guides

VALVE SEAT REPAIR

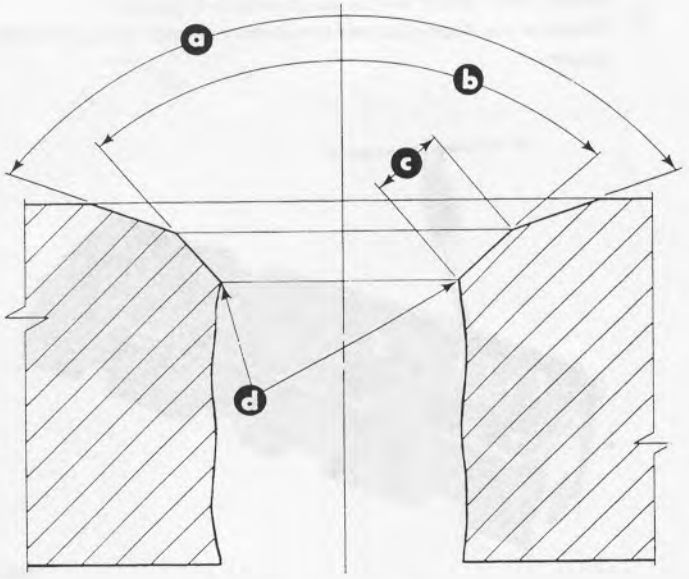
Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to insure that heat in valve head will be properly dispersed.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to insure proper centering of pilot in valve guide.

1. Install expanding pilot in valve guide bore and expand pilot.
2. Place roughing stone or forming stone over pilot and clean up valve seat only. Use a stone that is cut to specifications.
3. Remove roughing stone or forming stone from pilot, place finishing stone (cut to specifications) over pilot and cut just enough metal from seat to provide a smooth finish. Refer to "Specifications" and Figure 12.
4. Narrow down valve seats to specified width by grinding with a 30° stone to lower seat and a 60° stone to raise seat.



a - Top Edge "Approach Angle" (30°)
b - Seat Angle
c - Seat Width
d - Bottom Edge (60°)

Figure 12. Valve Seat in Cylinder Head

5. Remove expanding pilot and clean cylinder head carefully to remove all chips and grindings from above operations.
6. Measure valve seat width. See "Specifications".
7. Measure valve seat "out-of-round". (Figure 13) See "Specifications".

Figure 13. Measuring Valve Seat Concentricity

VALVE REPAIR

Pitted valves can be refaced to proper angle on a valve grinder, thus insuring correct relation between cylinder head seat and valve mating surface. Replace valves with excessive wear on stems or valves which are warped excessively. When an excessively-warped valve head is refaced, a knife edge will be ground on part or all of the valve head, due to amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition caused by heat localizing in this knife edge. If edge of valve head is less than 1/32" (.8mm) thick after grinding, replace the valve.

Various equipment is available for refacing valves. Manufacturer's recommendations should be carefully followed to attain proper results.

1. If necessary, dress the valve refacing machine grinding wheel to make sure it is smooth and true. Set chuck at angle specified for valve. Refer to "Specifications".
2. Continue grinding until valve face is true and smooth all around the valve. If this makes valve head thin [1/32" (.8mm) minimum], valve must be replaced, or valve will overheat and burn. (Figure 14)
3. Remove valve from chuck and place stem in "V" block. Feed valve squarely against grinding wheel to grind any pit from rocker arm end of stem.

   IMPORTANT: Only extreme end of valve stem is hardened to resist wear. Do not grind end of stem excessively.

4. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks about ¼" (6mm) across the valve face, place valve in cylinder head and give valve ½-turn in each direction while exerting firm pressure on head of valve.
5. Remove valve and check face carefully. If all pencil marks have not been removed at point of contact with valve seat, repeat refacing operation and again recheck for proper seating.

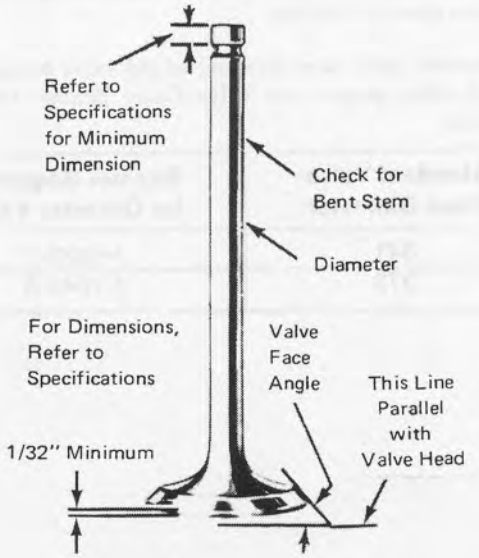


Figure 14. Critical Valve Dimensions

REASSEMBLY

- Lubricate valve guides and valve stems with engine oil.
- Install each valve in the port from which it was removed or to which it was fitted.
- Install valve stem oil seal, valve spring(s) and related parts on each valve as explained under "Valve Stem Oil Seal and/or Valve Spring".
- Compress valve spring with Tool J-8062.
- Check installed height of the valve springs with a narrow, thin scale. A cutaway scale will help. (Figure 15) Measure from top of spacer (spring seat) to top of valve spring. (Figure 16) If this exceeds specified height, install a valve spring seat shim approximately 1/16" (1.6mm) thick. At no time should spring be shimmed to give an installed height under minimum specified.

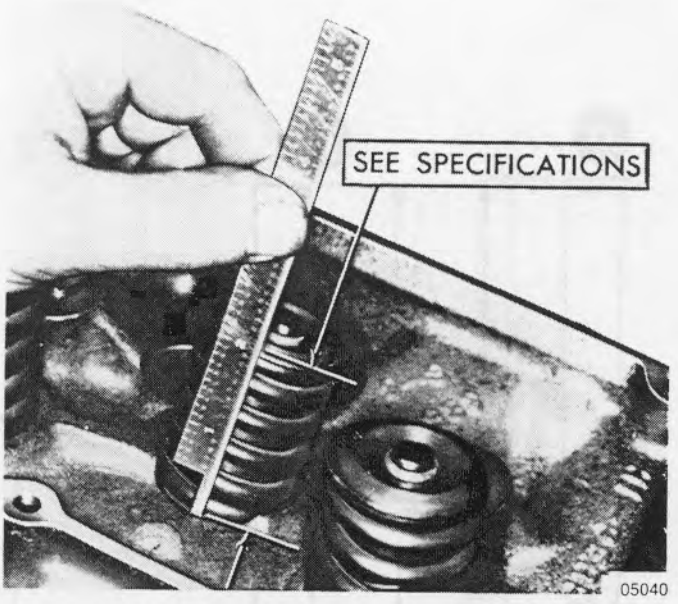


Figure 16. Measuring Valve Spring Installed Height

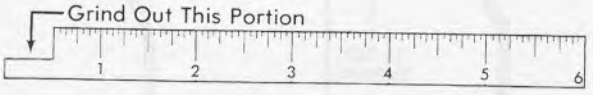


Figure 15. Cutaway Scale

OIL PAN

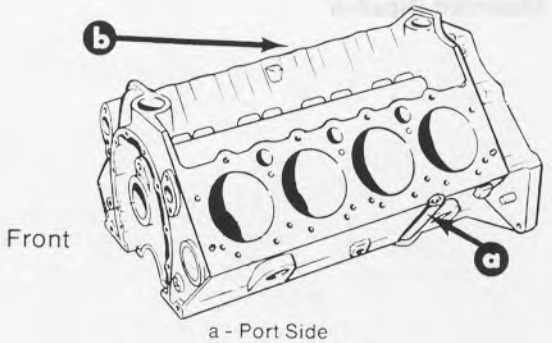
REMOVAL

1. Drain coolant.
2. Drain crankcase oil.
3. Remove oil dipstick and tube, if required.
4. Remove oil pan and discard gaskets.

305/350 CID ENGINE OIL PAN REPLACEMENT INFORMATION

Early cylinder blocks had the oil dipstick tube mounting hole on the port (left) side. Later cylinder blocks had the mounting hole on the starboard (right) side.

IMPORTANT: MIE engines normally have mounting hole plugged, however, this information applies to those engines also.



a - Port Side
b - Starboard Side

Figure 1. Oil Dipstick Tube Mounting Sides

Port Side Mounting Hole: Early MCM 898, 228, 260 and MIE 228, 255 engines.
Starboard Side Mounting Hole: Later MCM 898, 228, 260 and MIE 228, 255 engines. **All** MCM 898R, 228R, 260R and MIE 230, 260 engines.

IMPORTANT: Engines with Center Exhaust Outlet on exhaust manifold must use starboard side mounting hole cylinder blocks.

Oil Pan Baffle

MCM 898 engine: Baffle is part of oil pan.
All other engines: Determine which side of engine oil dipstick tube mounting hole is on and use appropriate one. Refer to Parts Manual.

Oil Pan

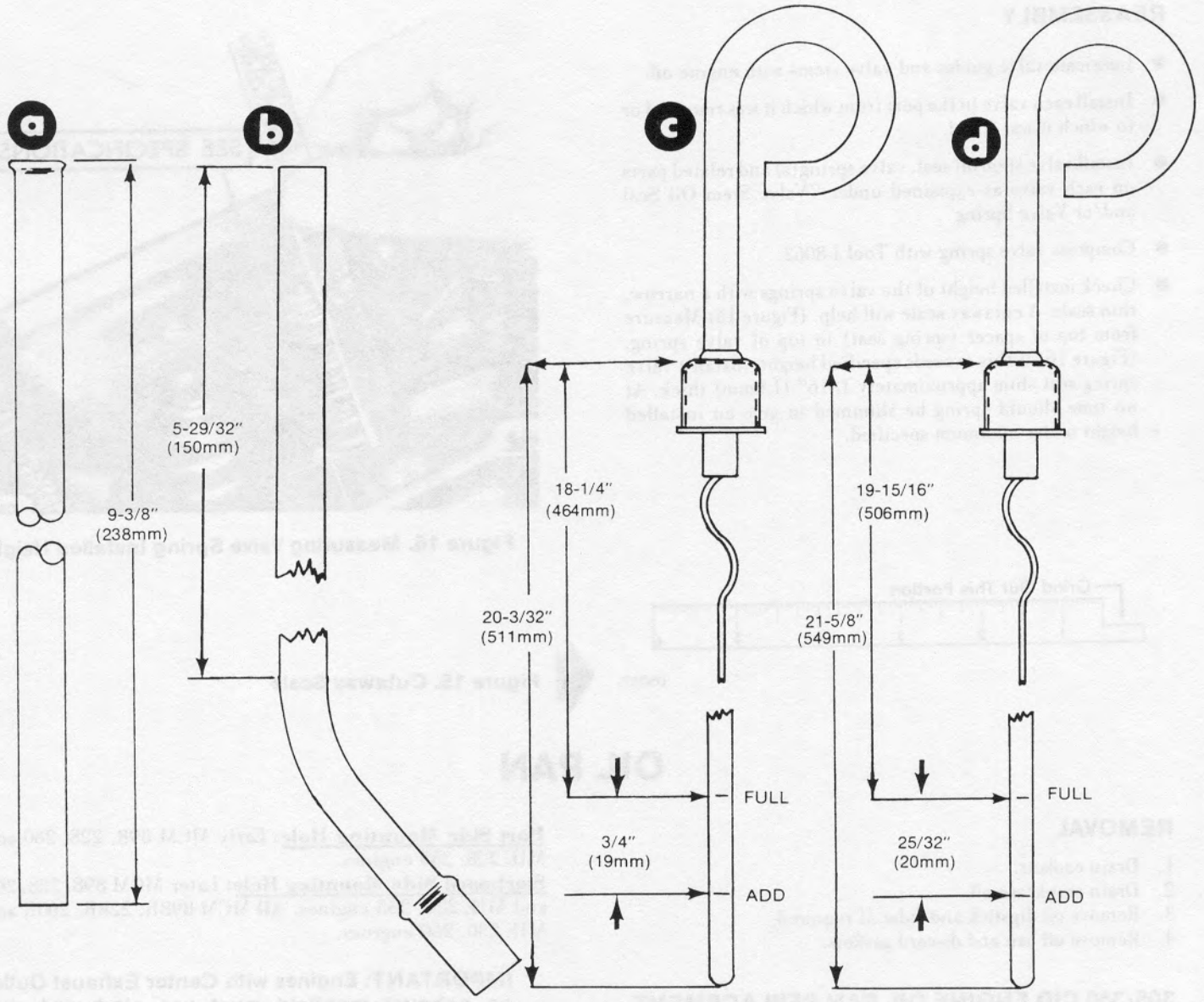
Determine which side of engine oil dipstick tube mounting hole is on and use appropriate one. Refer to Parts Manual.

Oil Pan Gasket

Determine which side of engine oil dipstick tube mounting hole is on and use appropriate one. Refer to Parts Manual.

Oil Dipstick and Tubes

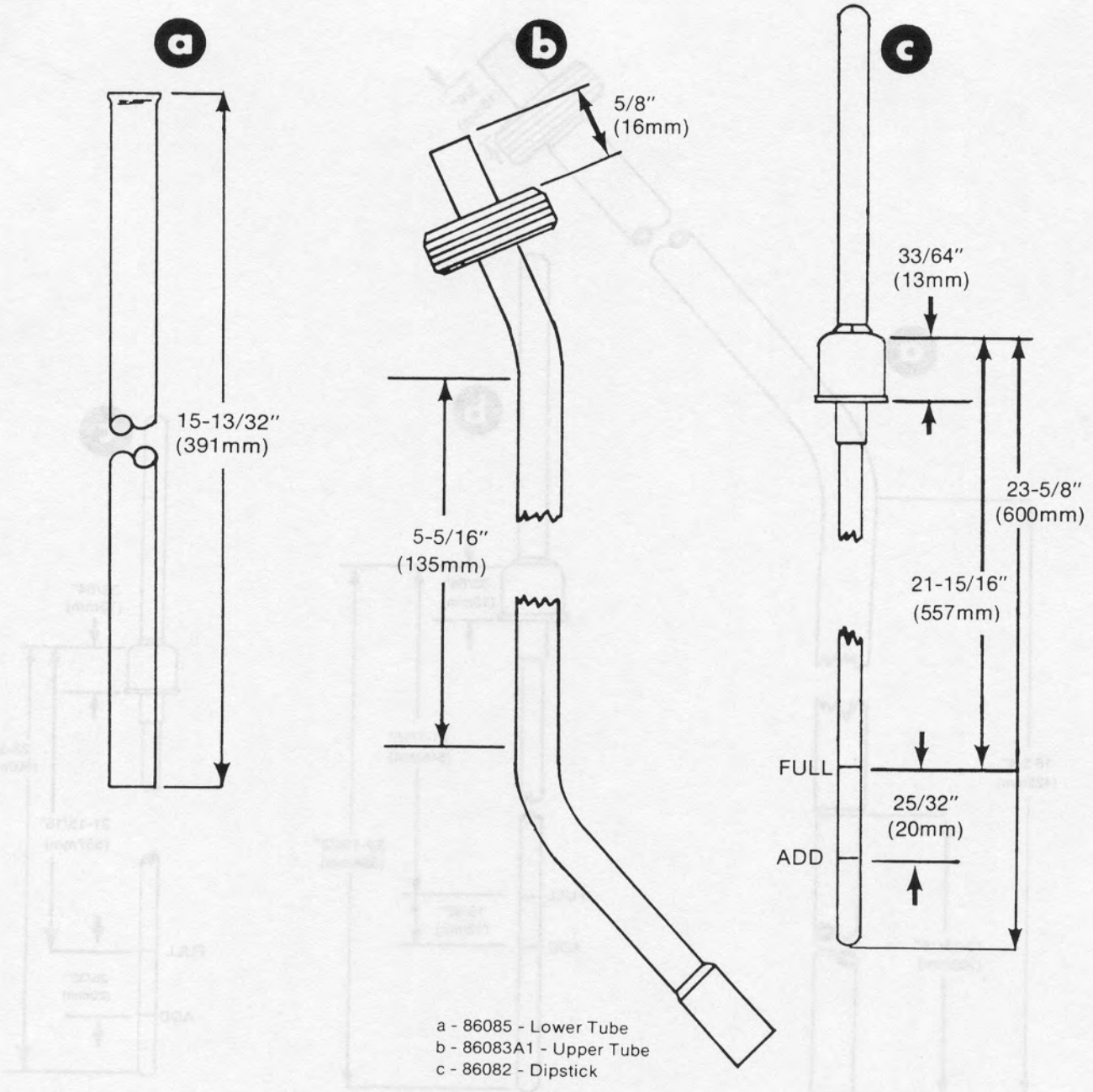
Refer to Parts Manual for part numbers, then refer to Figures 2, 3, 4, 5 or 6.



a - 72950 - Lower Tube
b - 32-72539 - Upper Tube
c - 77454 - Dipstick (MCM 898)
d - 72938 - Dipstick (MCM 228, 260)

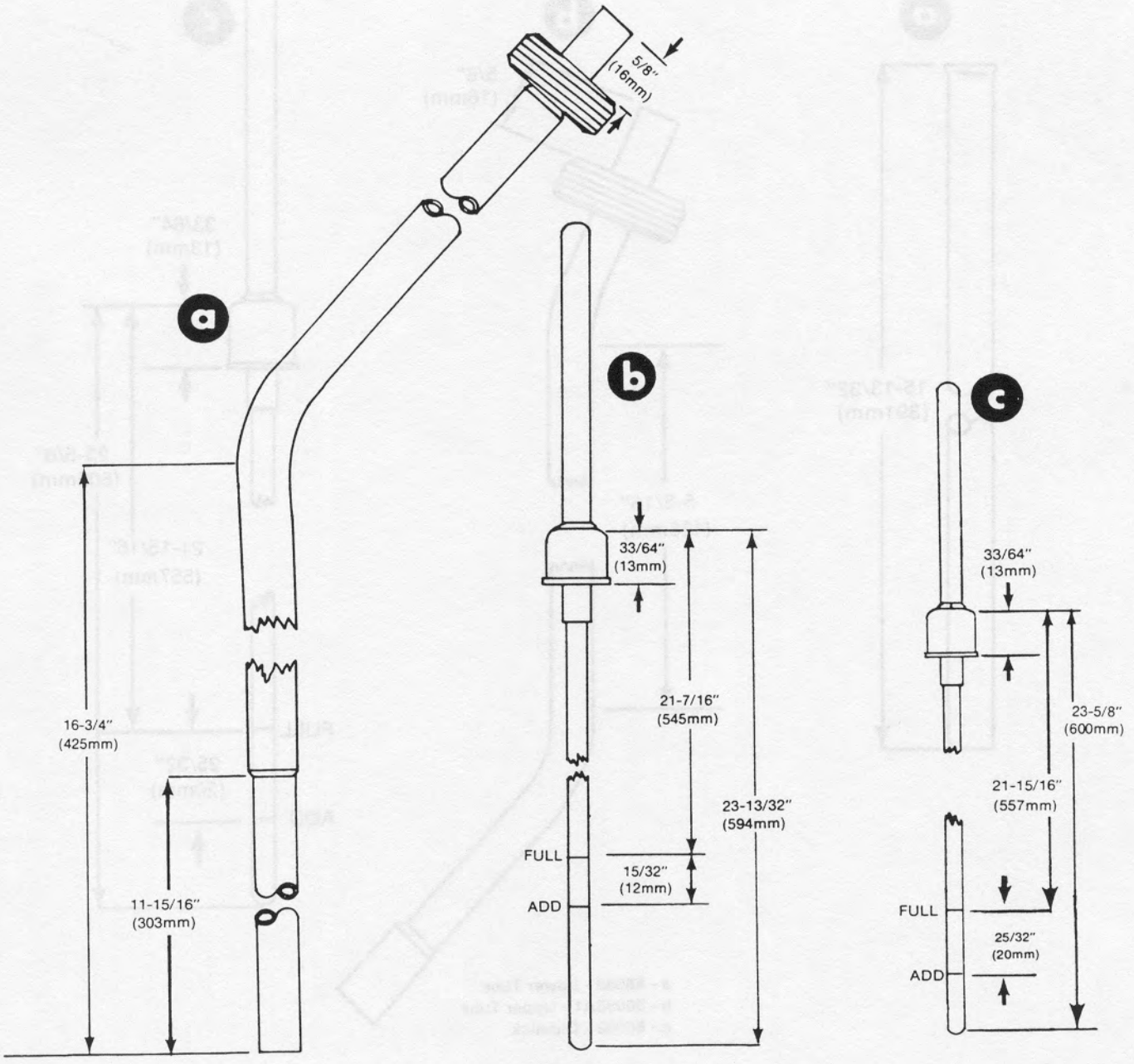
Used on: MCM 898 - S/N 5496181 and below
MCM 228 - S/N 5229542 and below
MCM 260 - S/N 5246183 and below

Figure 2. MCM Engines, Port Mounted Dipstick



Used on: MCM 228 - S/N 5229543-5515813
MCM 260 - S/N 5246184-5500136

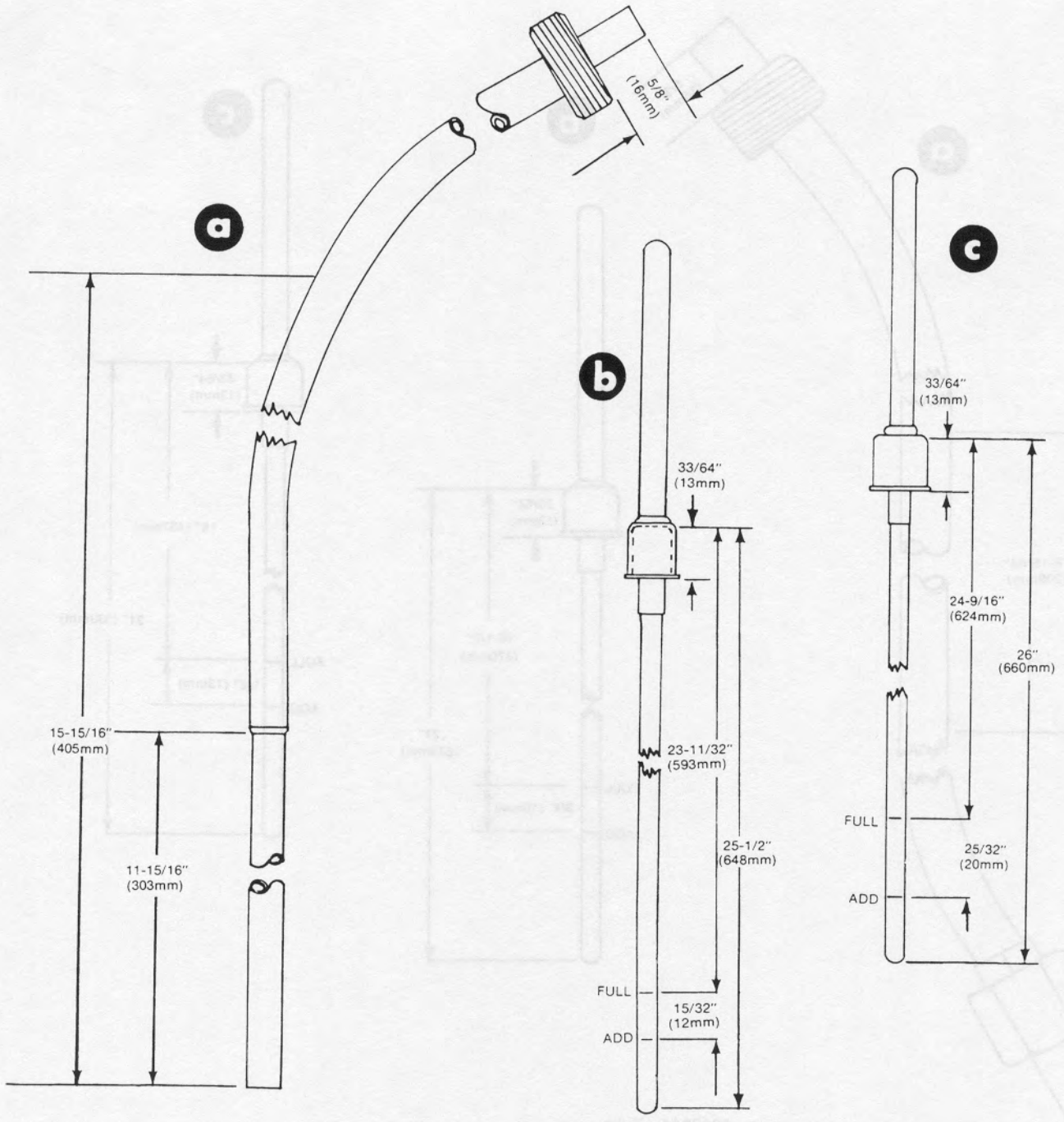
Figure 3. MCM Engines, Port Mounted Dipstick



a - 92078A1 - Tube
b - 73232 - Dipstick (MCM 898)
c - 86082 - Dipstick (MCM 228, 260)

Used on: MCM 898 - S/N 5496182-6218461
MCM 228 - S/N 5515814-6225266
MCM 260 - S/N 5500137-6227756

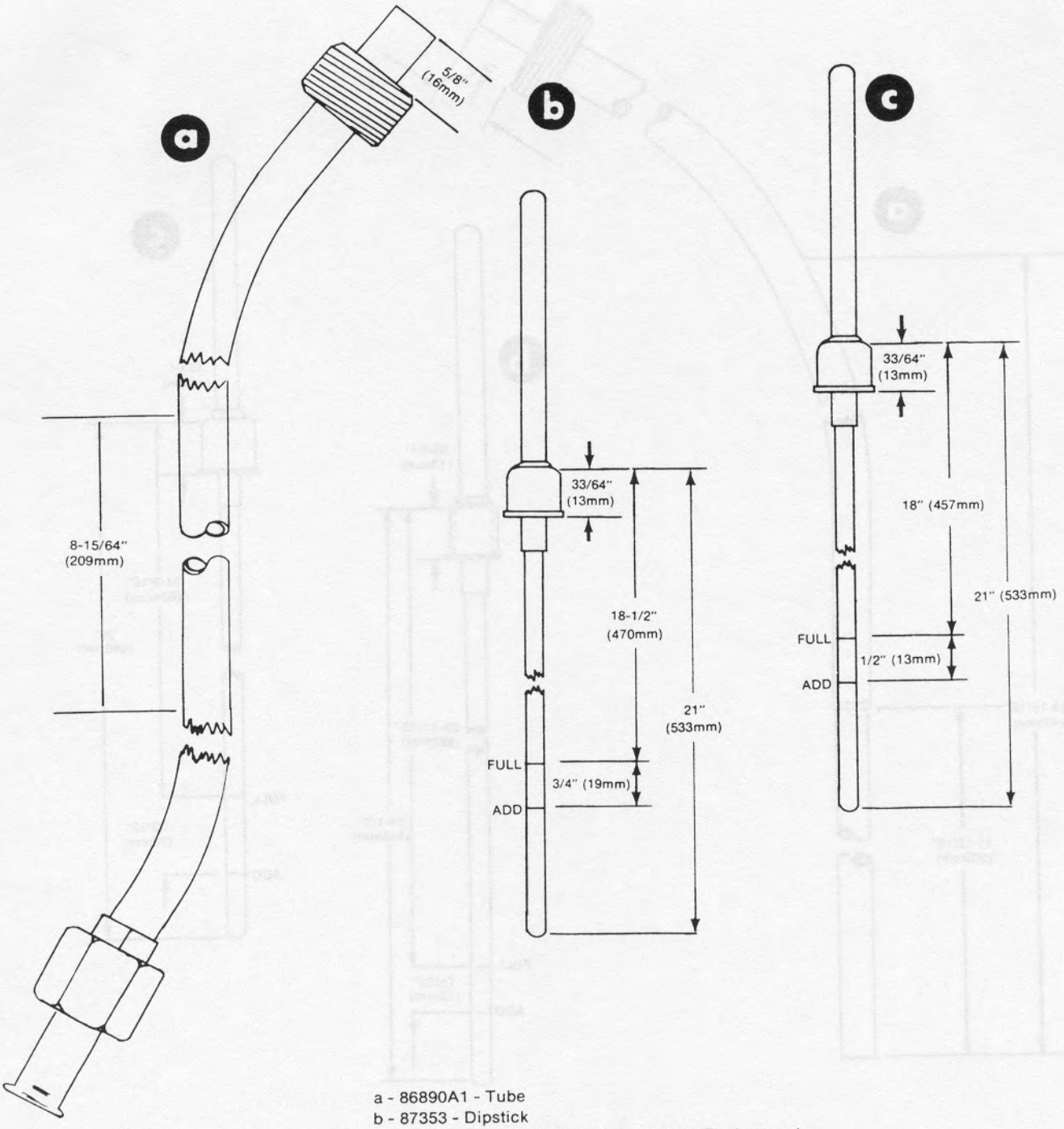
Figure 4. MCM Engines, Starboard Mounted Dipstick



a - 92163A2 - Tube
b - 96822A1 - Dipstick (MCM 898R)
c - 96418A1 - Dipstick (MCM 228R, 260R)

Used on: MCM 898R - S/N 6218462 and above
MCM 228R - S/N 6225267 and above
MCM 260R - S/N 6227757 and above

Figure 5. MCM Engines, Starboard Mounted Dipstick



a - 86890A1 - Tube
b - 87353 - Dipstick
c - 49457 - Dipstick (MIE 230/260 V-Drive Engines and Engines That are Mounted Near Horizontal)

Used on: MIE 228 - All
MIE 230 - All
MIE 255 - All
MIE 260 - All

Figure 6. MIE 305 and 350 CID Engines

INSTALLATION

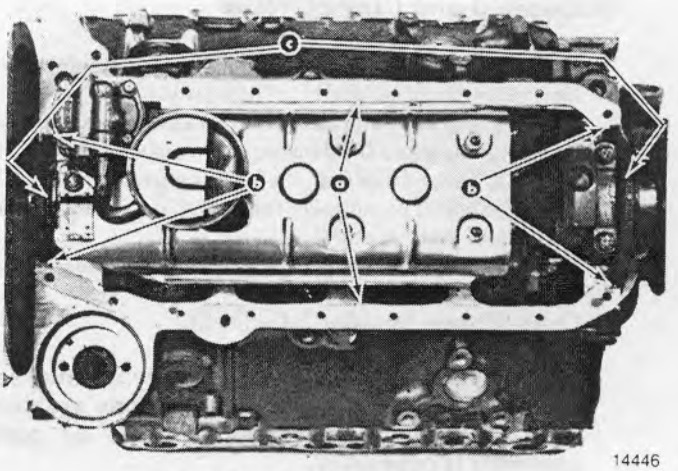
1. Thoroughly clean gasket and seal surfaces on oil pan, cylinder block, rear main bearing cap and crankcase front cover.

   IMPORTANT: 454 CID MIE and some MCM engines use a rubber plug to block off threaded holes into the cylinder block (located on each side of the rear main bearing cap). If oil pan does not have thru hole for attaching screw, install rubber plug to prevent oil leak.

2. Coat both sides of oil pan side gaskets with Perfect Seal and place gaskets in position on each side of cylinder block. (Figure 7)
3. Apply a ⅛" (3mm) bead of RTV Sealer to front and rear seal mating surfaces on cylinder block rear main bearing cap, front cover and gaskets. (Figure 7)

   IMPORTANT: RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

4. Install new front and rear seals, being sure ends of seals are butted properly against side gaskets.
5. Apply a ⅛" (3mm) bead of RTV Sealer to outer surface of seals. (Figure 7) This is extremely important on inboard and V-drive engines which have aluminum oil pans.

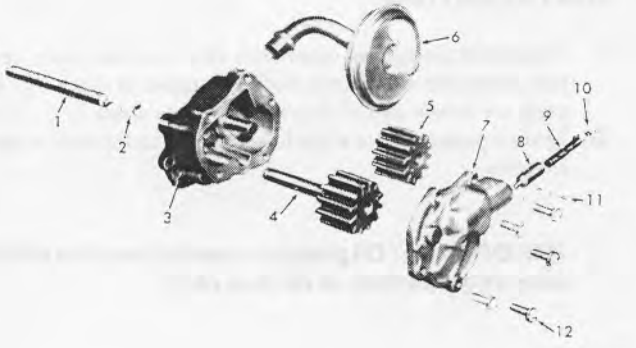


a - Coat Both Sides with Perfect Seal
b - Apply RTV to Mating Surfaces
c - Apply RTV to Outer Surface of Seals

Figure 7. Typical Oil Pan Gasket and Seal Locations

6. Carefully position oil pan against the block, being careful not to disturb gaskets and seals. Install oil pan attaching screws and washers. Torque screws to specifications, starting from center and working outward in each direction.
7. Install oil dipstick tube and dipstick.
8. Install engine in boat. Fill engine with oil, start engine and check for leaks.

OIL PUMP



1 - Shaft Extension
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Washer
11 - Retaining Pin
12 - Screws

Figure 1. Oil Pump Assembly

The oil pump consists of 2 gears and a pressure regulator valve enclosed in a 2-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

A baffle is incorporated on pickup screen to eliminate pressure loss and engine oil pump tubes are bent at special angles.

REMOVAL

1. Remove oil pan.
2. Remove pump to rear main bearing cap bolt and remove pump and extension shaft.

DISASSEMBLY (Figure 1)

1. Remove pump cover attaching screws and pump cover.

   IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear, drive gear and shaft from pump body.
3. Remove retaining pin, pressure regulator valve and related parts.

   IMPORTANT: 305 and 350 CID Engines: DO NOT remove pickup screen and pipe assembly, unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure.

   IMPORTANT: 454 CID Engines: Pickup screen and pipe assembly cannot be removed from pump.

   IMPORTANT: DO NOT disturb pickup screen on pipe. This is serviced as an assembly.

4. **305 and 350 CID Engines Only:** If pickup screen and pipe assembly requires replacement, mount pump in a soft jawed vise and extract pipe from pump.

CLEANING and INSPECTION

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen or pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

REASSEMBLY

⚠CAUTION

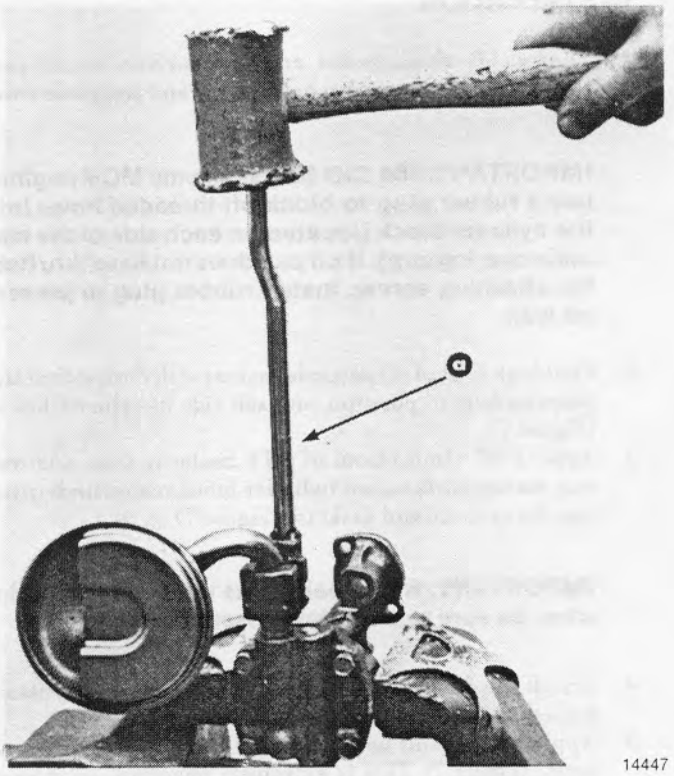
Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan rails when oil pump is installed.

305 and 350 CID Engines Only: If pickup screen and pipe assembly was removed, mount pump in a soft-jawed vise, apply Perfect Seal to end of new pipe and using Tool (J-8369), tap the pipe in place with a hammer. (Figure 2)

NOTE: Tool will have to be modified to fit later engines.

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear and shaft in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Install pump cover and torque attaching screws to specifications.
5. Turn drive shaft by hand to check for smooth operation.



a - J-8369 Tool

Figure 2. Installing New Pickup Screen and Pipe Assembly

INSTALLATION

1. Assemble pump and extension shaft to rear main bearing cap, aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.
2. Install pump to rear main bearing cap and torque to specifications.

IMPORTANT: Oil pump screen is installed with bottom edge parallel to oil pan rails.

3. Install oil pan as outlined.

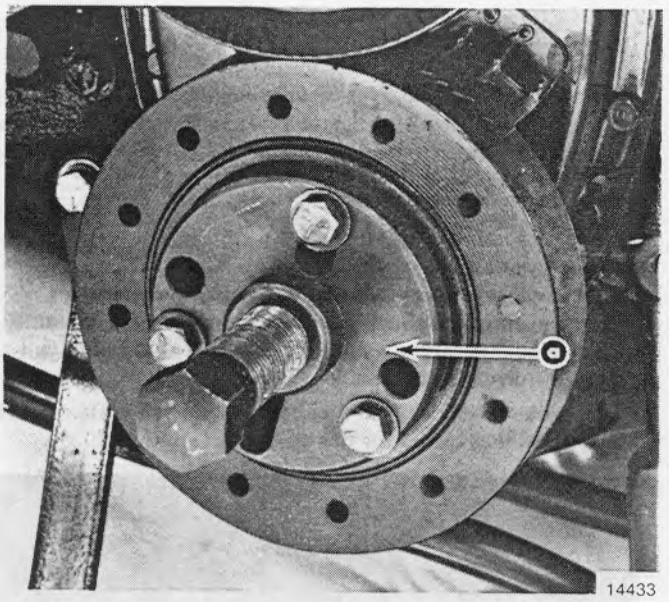
TORSIONAL DAMPER

REMOVAL

1. Remove drive belts.
2. Remove drive pulley, then remove damper retaining bolt.

IMPORTANT: DO NOT use a universal claw type puller to remove torsional damper (in next step) as outside ring of damper is bonded in rubber to the hub and use of claw type puller may break the bond.

3. Remove damper with Tool J-23523-03. (Figure 1)



a - J-23523-03 Tool

Figure 1. Removing Torsional Damper

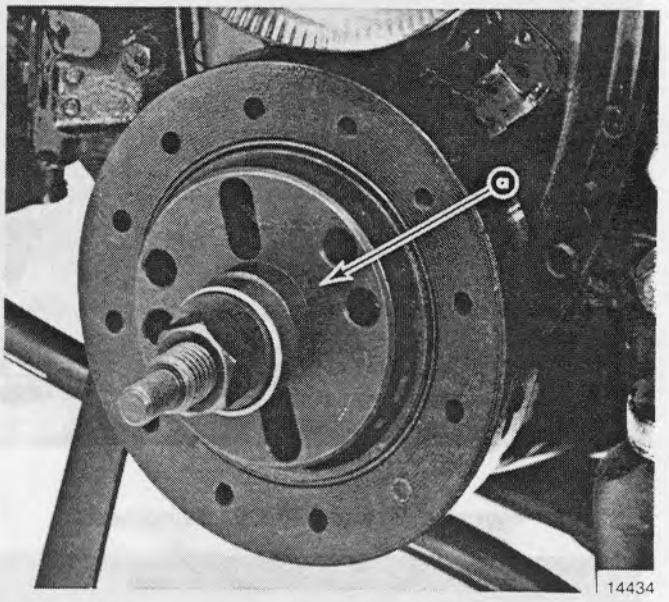
INSTALLATION

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) MUST BE followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Coat front cover seal contact area (on damper) with engine oil.
2. Pull damper onto crankshaft, using Tool J-23523-03, as follows: (Figure 2)
   a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft so that at least ½" (13mm) of thread engagement is obtained to prevent damage to threads.

   b. Install plate, thrust bearing, washer and nut on rod.
   c. Pull damper onto crankshaft (by turning nut) until it bottoms-out.



a - J-23523-03 Tool

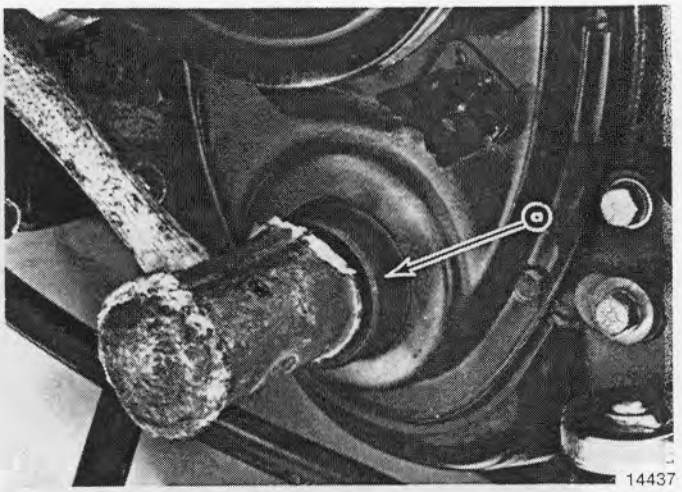
Figure 2. Installing Torsional Damper

   d. Remove tool from crankshaft, then, install damper retaining bolt and torque to specifications.
3. Install drive pulley(s).
4. Install and adjust drive belts.

CRANKCASE FRONT COVER/OIL SEAL

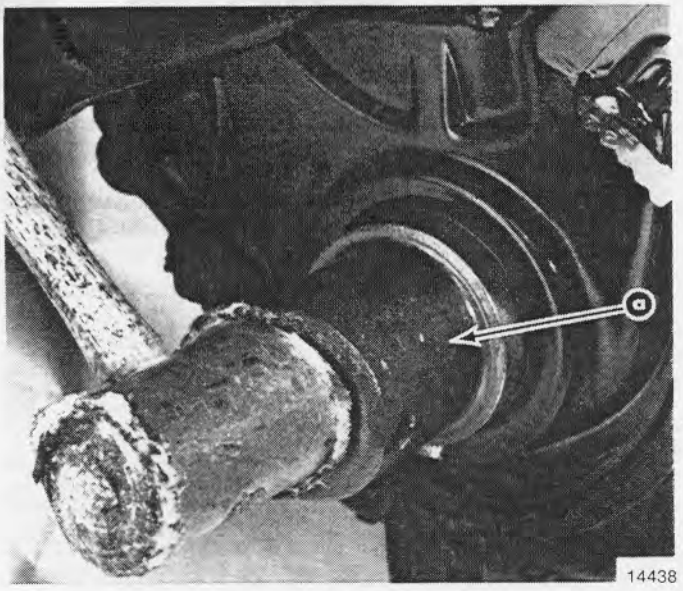
OIL SEAL REPLACEMENT (Without Removing Front Cover)

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft seal surface.
3. Install new seal with open end of seal inward, using Tool J-23042 on 305 and 350 CID engines or Tool J-22102 on 454 CID engines. (Figure 1 or 2) Drive seal in until it just bottoms out. DO NOT USE EXCESSIVE FORCE.
4. Reinstall torsional damper.



a - J-23042 Tool

Figure 1. 305 and 350 CID Engines



a - J-22102 Tool

Figure 2. 454 CID Engines

REMOVAL

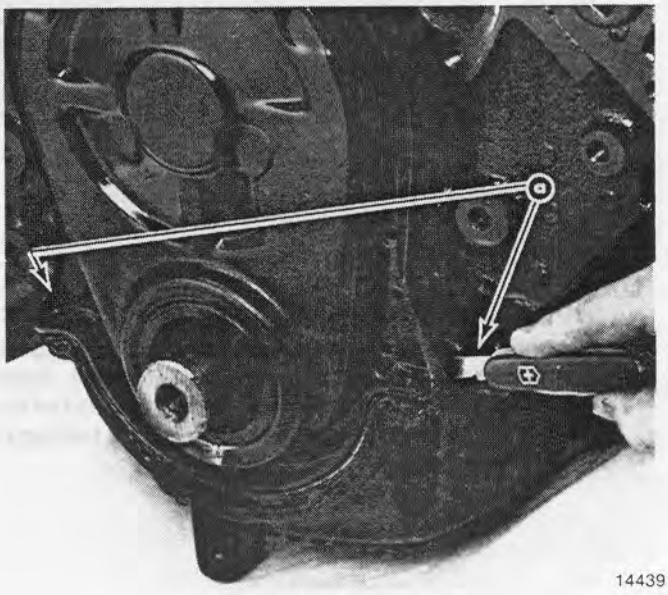
305 and 350 CID Engines:

1. Remove engine from boat.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.
4. Remove crankcase front cover attaching screws and remove cover. Remove and discard cover gasket.
5. If damaged, drive oil seal out of front cover (from the rear) with a punch.

454 CID Engines:

NOTE: The following instructions outline removal of front cover without removing oil pan. If oil pan must be removed for other engine service, remove oil pan and disregard Step 3, 4 and 5, following.

1. Remove torsional damper.
2. Remove water circulating pump.
3. Remove 2 oil pan to front cover attaching screws.
4. Remove crankcase front cover attaching screws and timing pointer, then pull cover slightly forward (only enough to permit cutting of oil pan front seal).
5. Using a sharp knife, cut oil pan front seal flush with cylinder block on both sides of cover. (Figure 3)

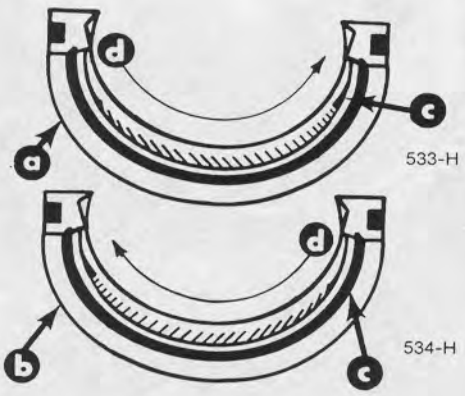


a - Cut Off Seal On Both Sides

Figure 3. Cutting Oil Pan Front Seal

6. Remove front cover and attached portion of oil pan front seal. Remove and discard oil pan front seal and front cover gasket.
7. If damaged, drive oil seal out of front cover (from the rear) with a punch.

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak. Refer to Figures 4 and 5.



a - MCM and MIE (L.H.) Rotation Engines
b - MIE (R.H.) Rotation Engines
c - Seal Lip Toward Inside of Engine
d - Rotation of Crankshaft as Viewed From Flywheel End Looking Forward

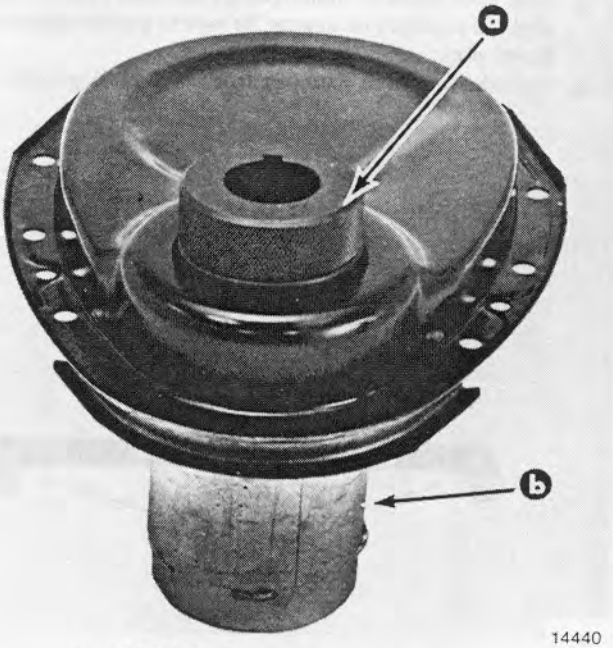
Figure 4. Front Seals WITH Helical Grooves

a - Can Be Used On Any Rotation Engine
b - Seal Lip Toward Inside of Engine

Figure 5. Front Seal WITHOUT Helical Grooves

305 and 350 CID Engines:

1. Clean front cover in solvent and dry with compressed air. Clean old gasket material and sealer from mating surfaces on cover and cylinder block. Check gasket surface on front cover for distortion and true if necessary. Surfaces MUST BE clean and flat or oil leakage may result.
2. Install oil seal in cover with lip of seal toward inside of engine, using Tool J-23042. (Figure 6) Support cover around seal area with appropriate tool as shown.
3. Coat both sides of front cover gasket with Perfect Seal and place in position on engine.
4. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching screws to specifications.
5. Install oil pan and torsional damper as outlined.
6. Install water circulating pump.
7. Reinstall engine in boat.
8. Fill crankcase with engine oil.
9. Start engine and check for water and oil leaks.



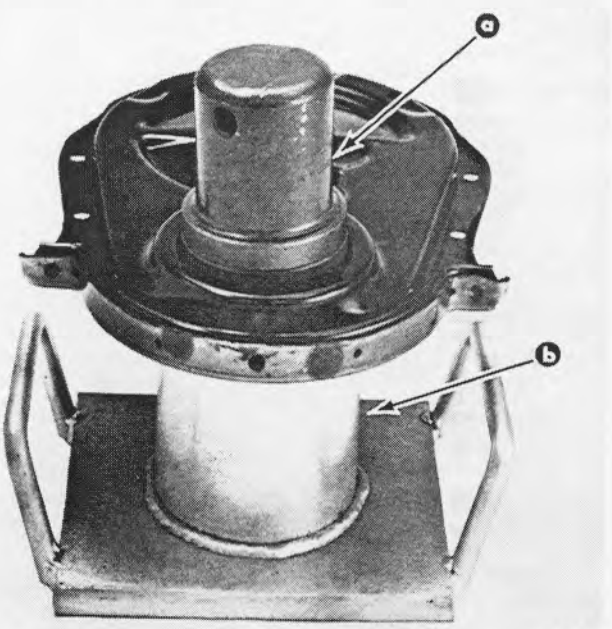
a - J-23042 Tool
b - Support (To Prevent Distorting Cover)

Figure 6. 305 and 350 CID Engines

454 CID Engines:

NOTE: The following instructions outline installation of front cover without oil pan removed. If oil pan has been removed for other engine service, disregard Step 3, 4, 6, 8 and 10 and install oil pan after front cover has been installed.

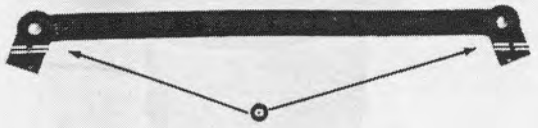
1. Clean front cover in solvent and dry with compressed air. Clean old gasket material and sealer from mating surfaces on cover and cylinder block. Check gasket surface on front cover for distortion.
2. Install oil seal in cover with lip of seal toward inside of engine, using Tool J-22102. (Figure 7) Support cover around seal area with appropriate tool as shown.



a - J-22102 Tool
b - Support (To Prevent Distorting Cover)

Figure 7. 454 CID Engines

3. Coat both sides of front cover gasket with Perfect Seal and place in position on engine. Be sure to position gasket over dowel pins.
4. Cut tabs from the new oil pan front seal. (Figure 8)



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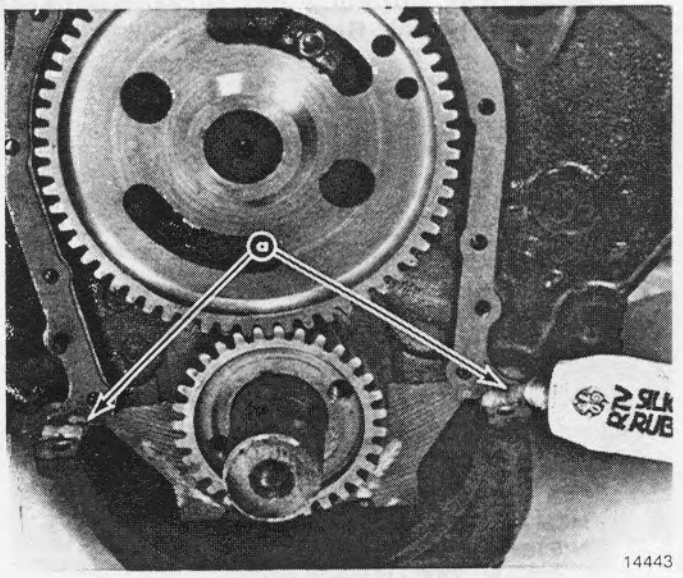
a - Cut This Portion From New Seal

Figure 8. Oil Pan Front Seal Modification (Without Oil Pan Removed Only)

5. Apply a ⅛" (3mm) wide bead of RTV Sealer across entire length of seal surface on front cover. Install seal to front cover, pressing tips into holes provided in cover. After seal is installed, place a ⅛" wide bead of RTV Sealer across entire length of outer seal surface.

IMPORTANT: Use of RTV Sealer on outer surface of seal is essential on inboard and V-drive engines which have aluminum oil pans.

6. Apply a ⅛" (3mm) bead of RTV Sealer to the joints formed where oil pan mates against cylinder block. (Figure 9)



14443

a - 1/8" (3mm) Wide Bead of RTV Sealer

Figure 9. RTV Sealer Applied to Oil Pan to Cylinder Block Joints

7. Position crankcase front cover over crankshaft.
8. Press front cover downward against oil pan until holes in cover align with dowel pins on block and push cover over pins. Install and partially tighten the 2 oil pans to front cover attaching screws to retain cover.
9. Install front cover attaching screws and timing pointer (if removable). Torque screws to specifications.
10. Torque 2 oil pans to front cover attaching screws (installed in Step 8) to specifications.
11. Install torsional damper.
12. Install water circulating pump.
13. Start engine and check for water and oil leaks.

FLYWHEEL

REMOVAL

1. Remove engine from boat.
2. Remove transmission, if so equipped.
3. Remove flywheel housing and related parts, if applicable.

   NOTE: On MCM engines with Mercury Marine transmission, flywheel housing is part of transmission.

4. **On I-Drive Engines:** Remove flywheel and coupler attaching nuts and washers and remove coupler and flywheel.
5. **On Engines with Borg-Warner or Mercury Marine Transmission:** Remove drive plate attaching screws and washers and remove drive plate, then remove flywheel attaching screws and washers and remove flywheel.
   a. **On Engines with Mercury Marine Transmissions Only:** If inspection of pilot bushing (in end of crankshaft) reveals that it must be replaced, remove bushing with suitable tool.

   IMPORTANT: If crankshaft is to be replaced, but old pilot bushing is to be reused, bushing can be removed without damage by filling pilot bushing cavity with grease, then, inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity which should force bushing out.

INSPECTION

1. Inspect drive plate for wear, on engines so equipped.
2. Check flywheel ring gear for worn or missing teeth.
3. Inspect engine coupler, on engines so equipped.
4. **Engines with Mercury Marine Transmission:** Inspect pilot bushing in end of crankshaft for damage.

INSTALLATION

1. Clean mating surfaces of flywheel and crankshaft.
   a. **On Engines with Mercury Marine Transmissions Only:** If inspection of pilot bushing (in end of crankshaft) reveals that it must be replaced, remove bushing with suitable tool.

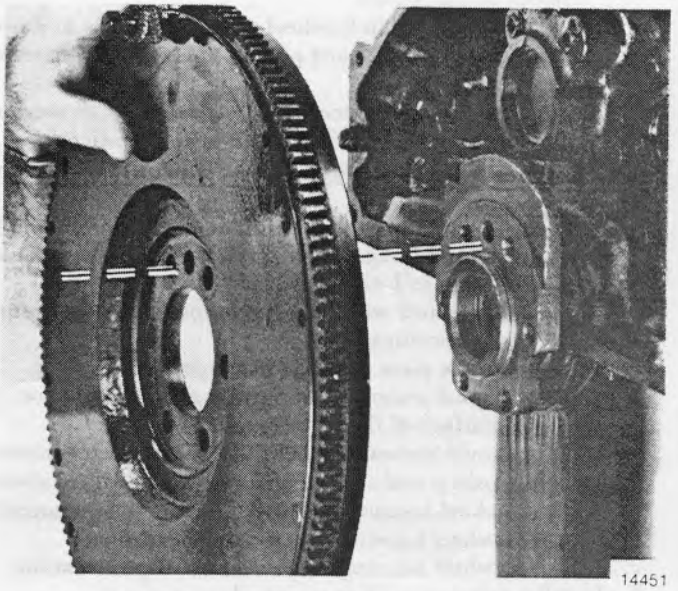


Figure 1. 305 and 350 CID Engines

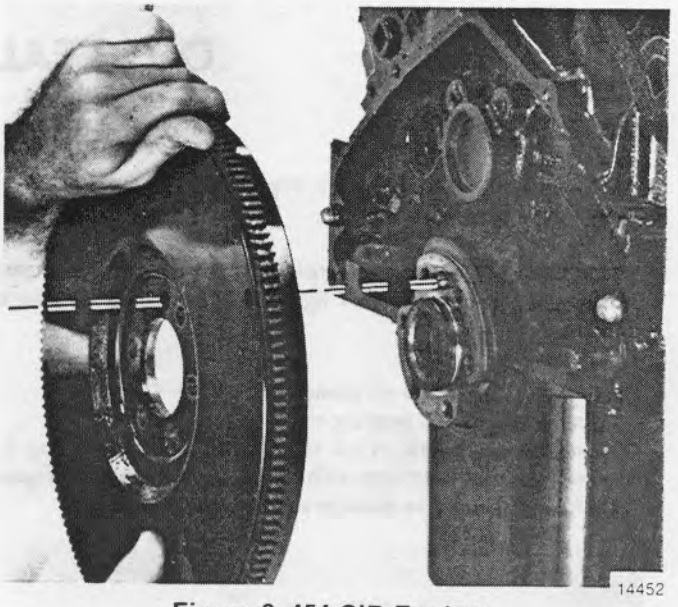
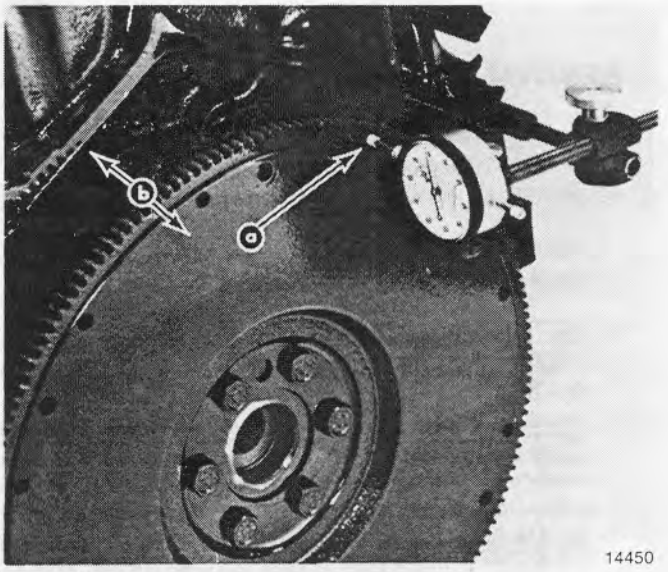


Figure 2. 454 CID Engines

2. **On I-Drive Engines:**
   a. If removed, apply Loctite 35 to threads of studs and install in crankshaft.
   b. Align dowel hole in flywheel with dowel hole or dowel in crankshaft flange and place flywheel in position on flange. (Figure 1)
   c. Install coupler and secure it and flywheel with washers and elastic stop nuts. Torque nuts to specifications.
3. **On Engines with Borg-Warner or Mercury Marine Transmission:**
   a. Align dowel hole in flywheel with dowel or dowel hole in crankshaft flange and place flywheel in position on flange. (Figure 1 or 2)
   b. Secure flywheel with screws and lockwashers. Torque screws to specifications.
   c. Install drive plate and torque to specifications.
4. Check flywheel runout by mounting dial indicator on machined surface of flywheel. (Figure 3)
5. Runout should not exceed .008" (.203mm). If excessive, remove flywheel and check for burrs or replace flywheel.
6. Install flywheel housing and related parts, if so equipped. Torque flywheel housing screws to specifications.
7. Torque flywheel housing cover screws to specifications.
8. Install transmission, if so equipped.
9. Install engine in boat.



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a - .008" (.203mm) Max. Runout
b - Hold Flywheel and Crankshaft Forward or Rearward As Far As It Will Go When Taking Reading

Figure 3. Checking Flywheel Runout

OIL SEAL (REAR MAIN)

REPLACEMENT

Rear main bearing oil seal can be replaced (both halves) without removing crankshaft.

IMPORTANT: Always replace upper and lower seal as a unit. Install with lip facing toward inside of engine.

1. Remove oil pan and oil pump.
2. Remove rear main bearing cap.
3. Remove lower half of oil seal from the bearing cap by prying from the bottom with a small screwdriver. (Figure 1) Be careful not to damage seal seating surface.

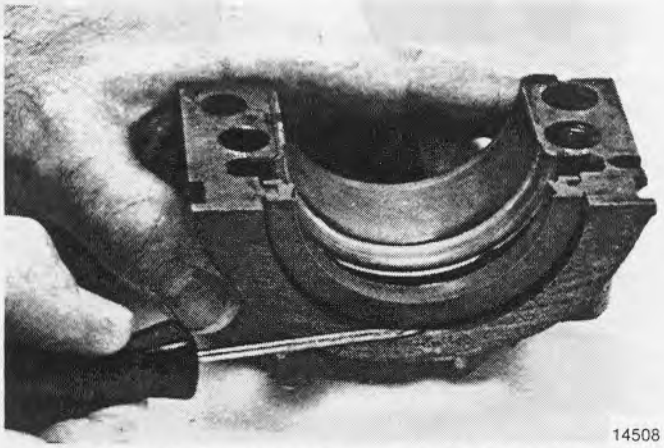
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Figure 1. Removing Lower Half of Oil Seal

4. Using a hammer and a soft metal punch, tap upper half of oil seal on one end until it protrudes far enough on the other end to remove it with a pliers. (Figure 2)

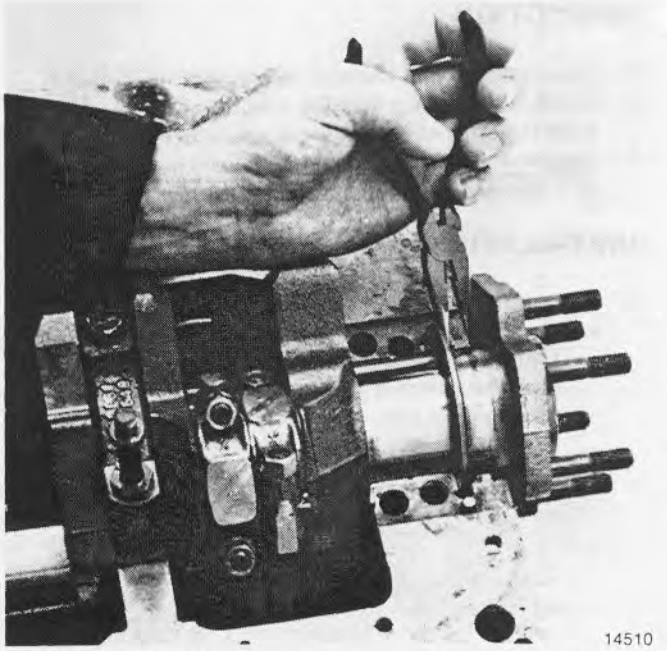
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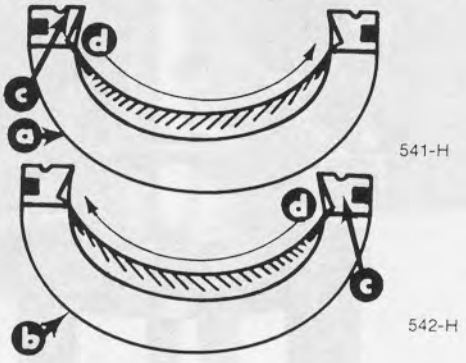
Figure 2. Removing Upper Half of Oil Seal

5. Clean, rear main bearing cap, cylinder block and crankshaft with solvent and blow dry with compressed air. Be sure all of the old sealer is removed from bearing cap and cylinder block mating surfaces.

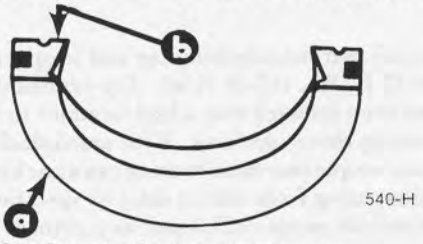
INSTALLATION

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak. Refer to Figures 3 and 4.



a - MCM and MIE (L.H.) Rotation Engines
b - MIE (R.H.) Rotation Engines
c - Seal Lip Toward Inside of Engine
d - Rotation of Crankshaft as Viewed From Flywheel End Looking Forward

Figure 3. Rear Seals WITH Helical Grooves



a - Can Be Used On Any Rotation Engine
b - Seal Lip Toward Inside of Engine

Figure 4. Rear Seal WITHOUT Helical Grooves

Extreme care must be exercised when installing seal to prevent damage to sealing bead, located in the channel on outside diameter of the seal. To protect this bead, installation tool (Figure 5) MUST BE used. Construct tool using .004" (.1mm) shim stock, if tool is not supplied with seal.

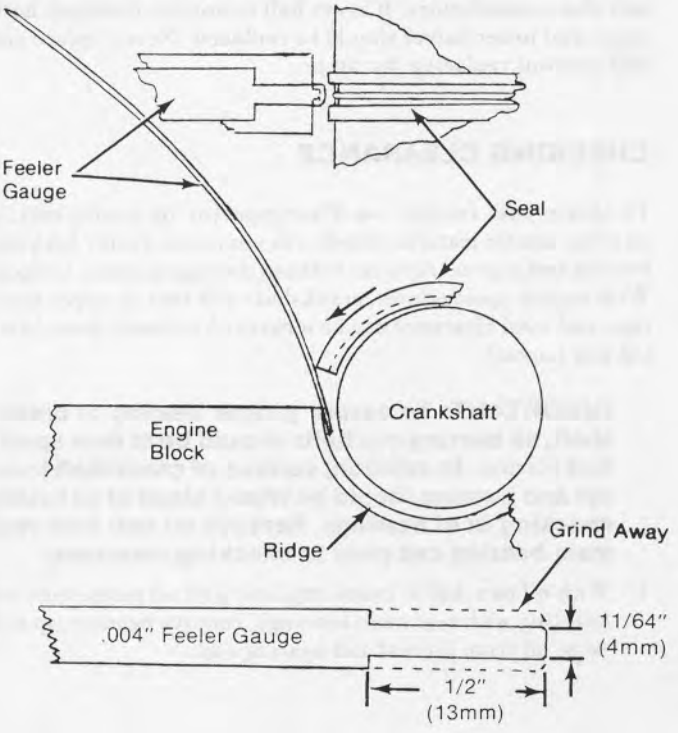


Figure 5. Installing Rear Main Seal - Cylinder Block Inverted

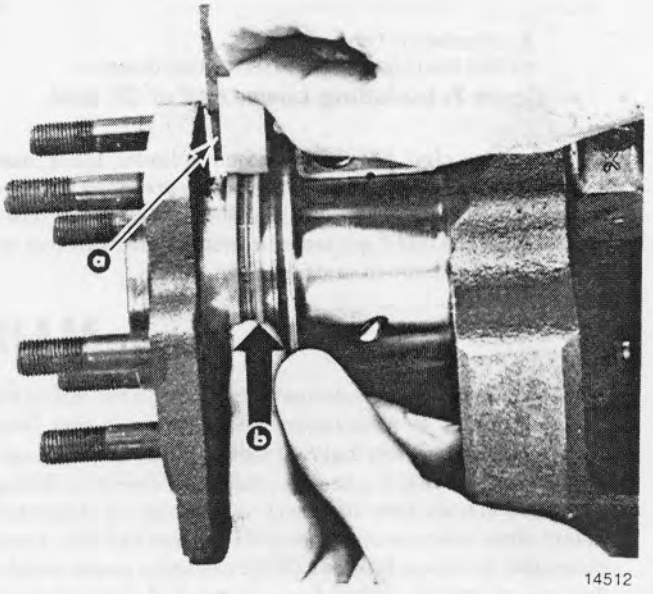
1. Coat lips and sealing bead on new rear oil seal with engine oil. Keep oil off of seal parting surfaces.

   IMPORTANT: Be sure to install oil seal with lip facing toward inside of engine.

2. Install upper half of oil seal: (Figure 6)
   a. Position tip of installation tool (Figure 5) between crankshaft and seal seating surface in cylinder block.
   b. Position upper half of seal between crankshaft and tip of installation tool so that seal bead contacts tip of tool.
   c. Roll upper half of seal around crankshaft using installation tool as a "shoe-horn" to protect seal bead from sharp corner of seal seating surface.

      IMPORTANT: Installation tool must remain in position until seal is properly positioned with both ends flush with block.

   d. After both ends of seal half are flush with block, remove installation tool.



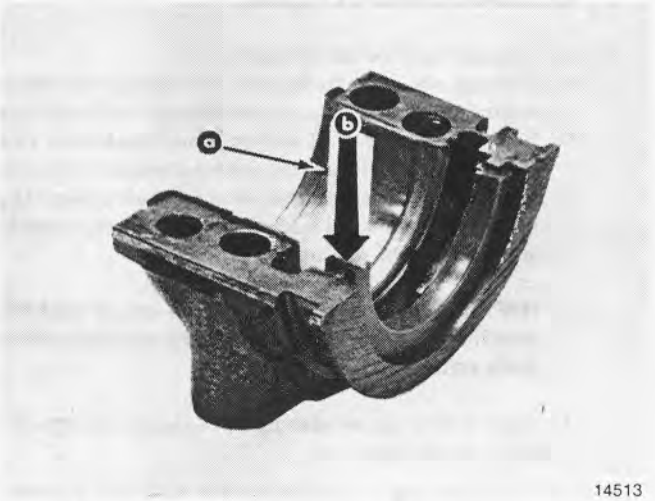
a - Installation Tool
b - Roll Seal Into Place In This Direction

Figure 6. Installing Upper Half of Oil Seal

3. Install lower half of oil seal: (Figure 7)
   a. Position oil seal half in rear main bearing cap so that one end is slightly below mating surface and seal lip is facing toward bearing. DO NOT allow sealing bead on other end of seal half to contact seal seating surface.
   b. Insert installation tool in between sealing bead and seal seating surface, then, using tool as a "shoe-horn" to

protect sealing bead from sharp corner of seal seating surface, roll seal into place. Seal is properly positioned when both ends are flush with cap.

c. Remove installation tool.



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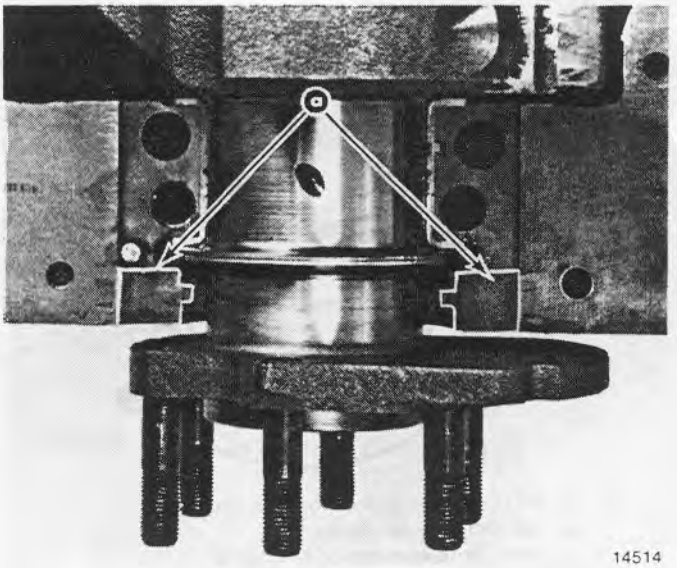
a - Installation Tool
b - Roll Seal Half Into Position in This Direction

Figure 7. Installing Lower Half of Oil Seal

4. Make sure that bearing cap and cylinder block mating surfaces and oil seal parting surfaces are clean and free of oil, then apply Perfect Seal to block at locations shown in Figure 8. DO NOT get sealer on seal parting surfaces or on surfaces adjacent to main bearing inserts.



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a - Apply Perfect Seal to Outlined Area Only

Figure 8. Applying Sealer to Block

5. Install rear main bearing cap and torque attaching bolts to 10-12 ft. lbs. (13-16 N.m). Tap crankshaft first rearward and then forward with a lead hammer to line up rear main bearing thrust surfaces. With crankshaft in forward position, torque rear main bearing cap attaching bolts EVENLY (alternating from side to side) to specifications.
6. Install oil pump and oil pan as outlined.

MAIN BEARINGS

Main bearings are precision insert type and do not utilize shims for adjustment. If clearances are excessive, a new bearing (both upper and lower halves) will be required. Bearings are available in standard size and undersize. Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. Consequently, one half of a standard insert may have one half of a .001" undersize insert which will decrease clearance .0005" from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it then is ground .009" (.229mm) undersize on main journals only. A .009" undersize bearing and .010" undersize bearing may be used for precision fitting in the same manner as previously described. Any engine fitted with a .009" undersize crankshaft will be identified by the following markings:

- ".009" will be stamped on crankshaft counterweight forward of center main journal.
- A figure "9" will be stamped on block at left front oil pan rail.
- A crankshaft with an undersize journal will be painted with light green on each side of the affected journal.

IMPORTANT: If crankshaft has an undersize journal and a new bearing is required, journal MUST BE reconditioned to accept a .010" or a .020" undersize bearing as .009" undersize bearings are not available for service.

INSPECTION

In general (except No. 2 bearing), lower half of bearing shows a greater wear and most distress from fatigue. After inspection, if lower half is suitable for use, it can be assumed that the upper half also is satisfactory. If lower half is worn or damaged, both upper and lower halves should be replaced. Never replace one half without replacing the other.

CHECKING CLEARANCE

To obtain best results, use Plastigage (or its equivalent), a wax-like plastic material which will compress evenly between bearing and journal surfaces without damaging either surface. With engine upside-down, crankshaft will rest on upper bearings, and total clearance can be measured between lower bearing and journal.

IMPORTANT: To assure proper seating of crankshaft, all bearing cap bolts should be at their specified torque. In addition, surface of crankshaft journal and bearing should be wiped clean of oil before checking fit of bearings. Remove oil seal from rear main bearing cap prior to checking clearance.

1. With oil pan, baffle (some engines) and oil pump removed (starting with rear main bearing), remove bearing cap and wipe oil from journal and bearing cap.

2. Place a piece of gauging plastic full width of bearing (parallel to crankshaft) on journal. (Figure 1)

IMPORTANT: Do not rotate crankshaft while gauging plastic is between bearing and journal.

3. Install bearing cap and torque retaining bolts evenly to specifications.

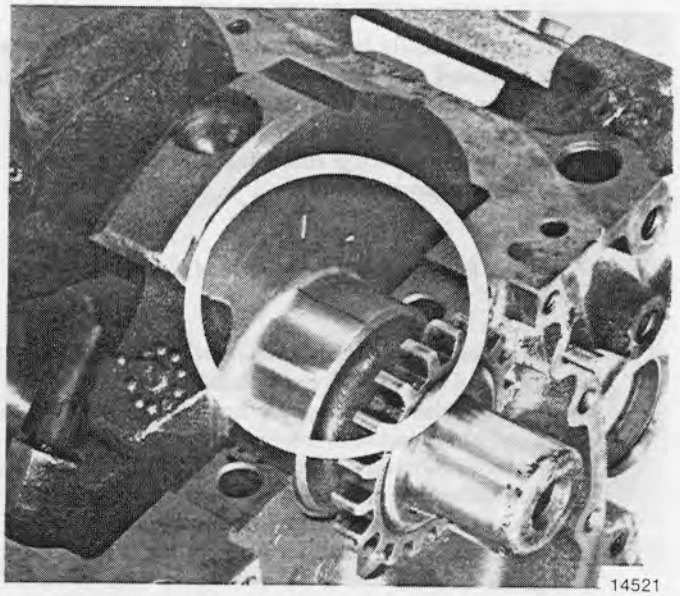


Figure 1. Gauging Plastic on Journal

4. Remove bearing cap. Flattened gauging plastic will be found adhering to either bearing shell or journal.
5. Use graduated scale (correlated in thousandths of an inch) on edge of gauging plastic envelope. Without removing gauging plastic, measure its compressed width (at widest point) with graduations on gauging plastic envelope. (Figure 2)

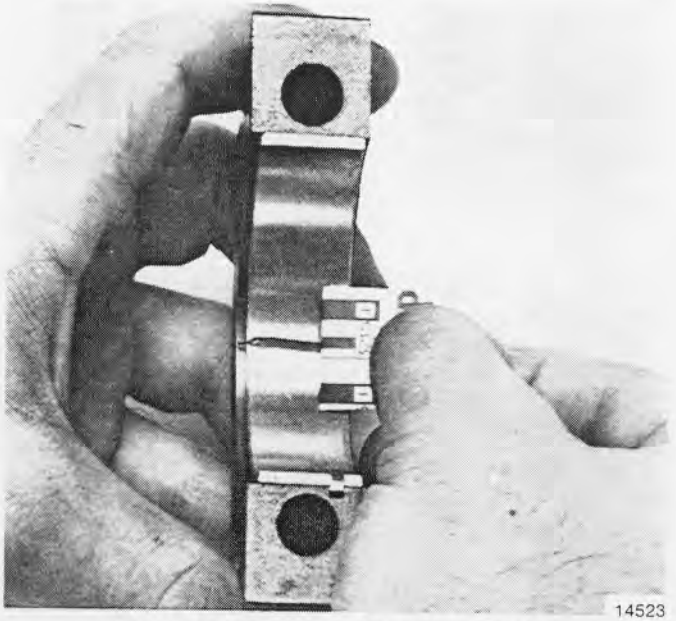


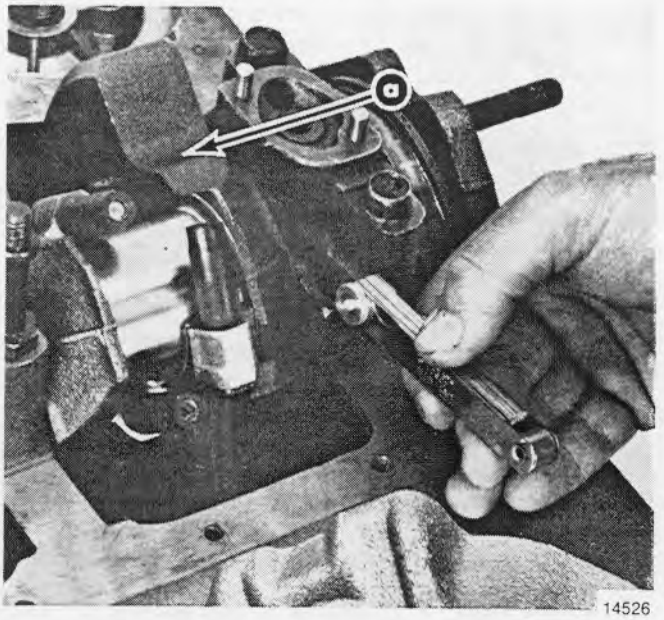
Figure 2. Measuring Gauging Plastic

IMPORTANT: Main bearing journals usually wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" [0.25mm] maximum), be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer if flattened gauging plastic indicates more than .001" difference.

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace the insert. Always replace both upper and lower insert as a unit.

IMPORTANT: If a new bearing cap is being installed and clearance is less than .001", inspect for burrs or nicks.

7. A standard .001" or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft to see that excessive drag does not exist.
9. Install front 4 main bearing caps and torque evenly to specifications.
10. Install rear main bearing cap and torque attaching bolts to 10-12 ft. lbs. (13-16 N.m). Tap end of crankshaft first rearward and then forward with a hammer to align rear main bearing thrust surfaces. With crankshaft in forward position, torque rear main bearing attaching bolts EVENLY (alternating from side to side) to specifications.
11. Measure crankshaft end play with a feeler gauge by forcing crankshaft forward and measuring clearance between the front of the rear main bearing and the crankshaft. (Figure 3) If clearance is excessive rear main bearing and/or crankshaft must be replaced.
12. Install a new rear main bearing oil seal in cylinder block and main bearing cap, as outlined.

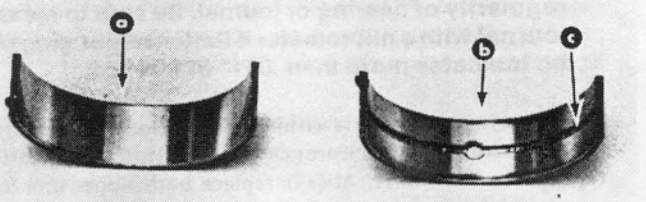


a - Force Crankshaft Forward

Figure 3. Measuring Crankshaft End Play

REPLACEMENT

NOTE: Main bearings may be replaced with or without removing crankshaft.



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a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

Figure 4. Main Bearing Inserts

With Crankshaft Removed:

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in cylinder block and main bearing caps.
4. Install crankshaft.

Without Crankshaft Removed:

1. With oil pan, baffle (some engines), oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Replace main bearing upper half as follows:
   a. Install main bearing removing and installing tool in crankshaft journal oil hole.

   NOTE: If tool is not available, bend a cotter pin.

   b. Rotate crankshaft clockwise (as viewed from front of engine). This will roll upper bearing out of block.
   c. Oil new selected size upper bearing and insert plain (unnotched) end between crankshaft and notched side of block. Rotate bearing into place and remove tool from oil hole in crankshaft journal.
3. Oil new lower bearing and install in bearing cap.
4. Install main bearing cap with arrows pointing toward front of engine.
5. Torque main bearing cap bolts to specifications.

CONNECTING ROD BEARINGS

Connecting rod bearings are precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Bearings are available in standard size and undersize for new and used standard size crankshafts and reconditioned crankshafts.

INSPECTION and REPLACEMENT

1. With oil pan and oil pump removed, remove connecting rod cap and bearing.
2. Inspect bearing for wear or damage and replace unsatisfactory bearings.
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications, and a new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. Measure new or used bearing clearances with Plastigage or its equivalent.

IMPORTANT: If a bearing is being fitted to an out-of-round crankpin, be sure to fit to maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001" (.025mm) or more, interference between bearing and crankpin will result in rapid bearing failure.

a. Install bearing in connecting rod and cap.
b. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft). (Figure 1)

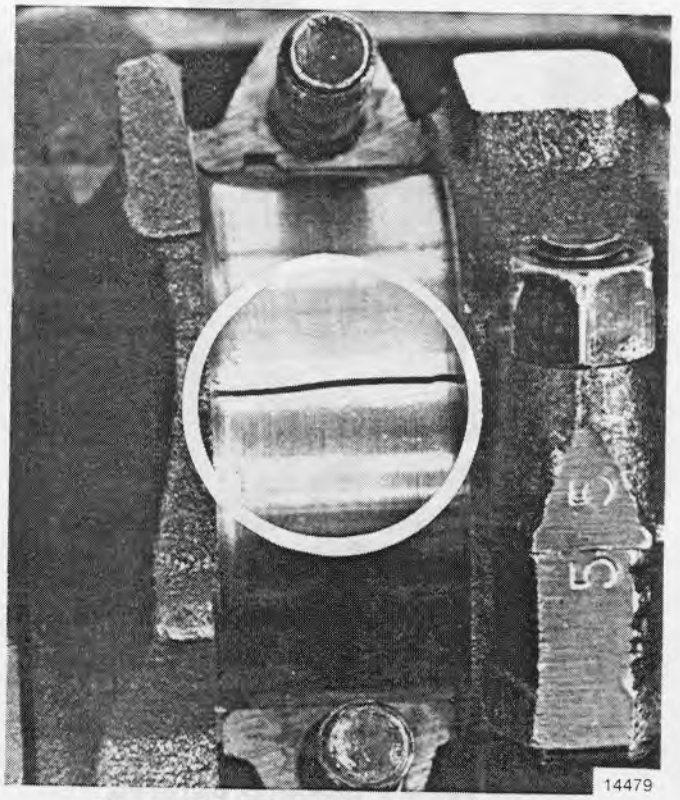


Figure 1. Gauging Plastic on Crankpin

c. Install bearing cap and torque nuts evenly to specifications.

IMPORTANT: Do not turn crankshaft with gauging plastic installed.

d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at the widest point. (Figure 2)

6. If clearance exceeds specifications, select a new, correct size bearing and recheck clearance.
7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances (see specifications) between connecting rod caps. (Figure 3)

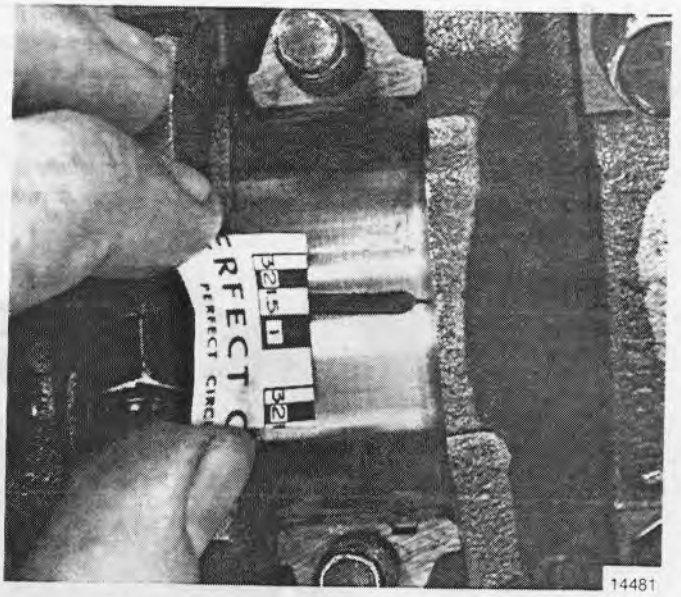


Figure 2. Measuring Gauging Plastic

Figure 3. Measuring Connecting Rod Side Clearance

CONNECTING ROD/PISTON ASSEMBLY

REMOVAL

1. With oil pan, baffle (some engines), oil pump and cylinder head removed, use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

2. Mark connecting rod and bearing caps left bank 1, 3, 5 and 7; right bank 2, 4, 6 and 8 from front to rear on same side as piston thrust.
3. Remove connecting rod cap and install tool J-5239 (3/8") or J-6305-1 (11/32") on bolts. (Figure 1) Push connecting rod and piston assembly out of top of cylinder block.

NOTE: It will be necessary to turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.

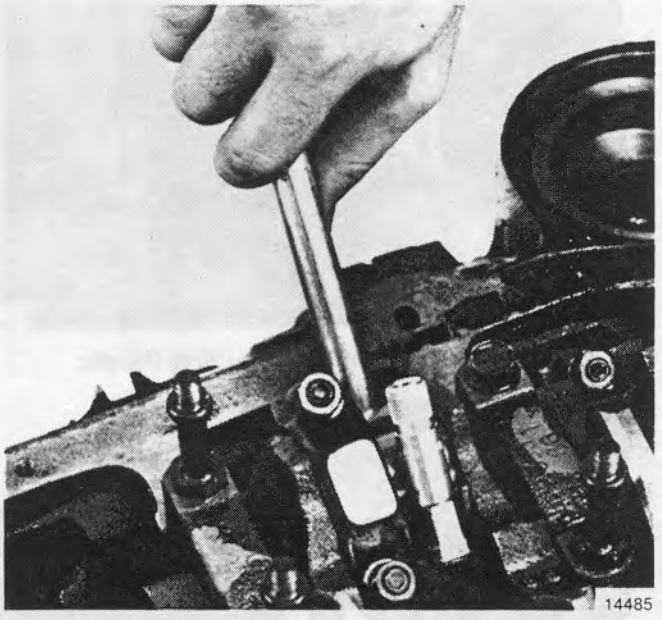
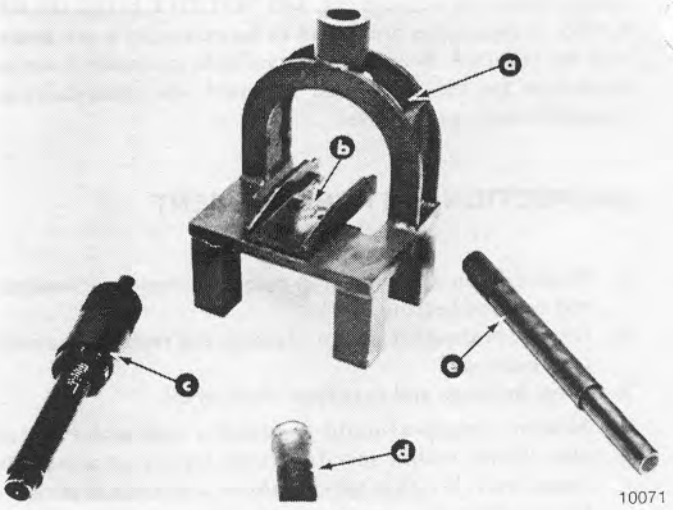


Figure 1. Removing Piston Assembly

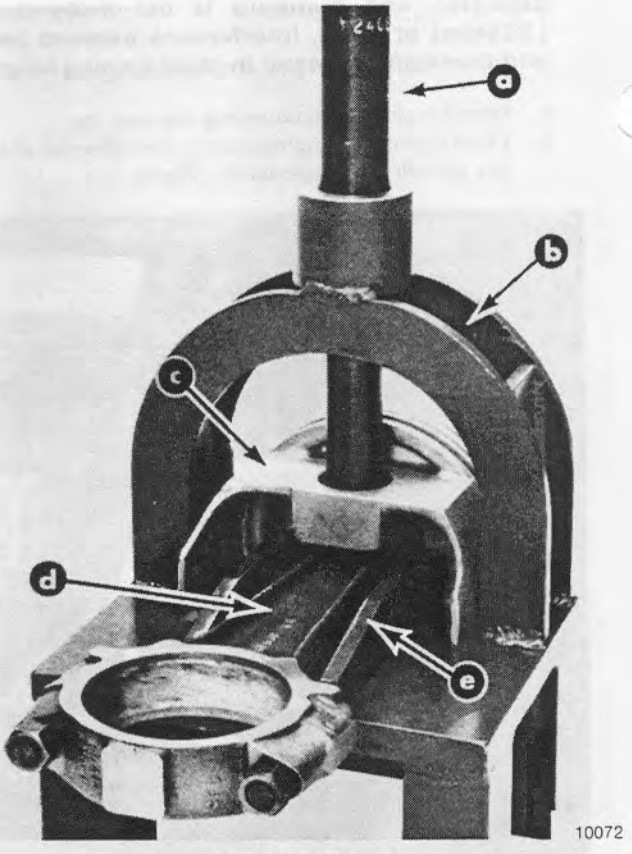
DISASSEMBLY

1. Use Tool Kit (J-24086-100), shown in Figure 2.
2. Position connecting rod onto tool rod support with rod support inserted between connecting rod end and piston. Align piston pin with hole located in top of arched base. (Figure 3)
3. Insert pin remover thru hole (located in top of arched base) and into piston pin hole. Press on pin remover to remove piston pin.



a - Arched Base
b - Rod Support
c - Adjustable Installer
d - Piston Pin Guide
e - Piston Pin Remover

Figure 2. Tool (J-24086-100) Parts Identification



a - Piston Pin Remover
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Figure 3. Removing Piston Pin

CLEANING and INSPECTION

Connecting Rods:

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for nicks or cracks. Replace damaged connecting rods.

Pistons:

1. Clean varnish from piston skirts and pins with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes and slots are clean.
2. Inspect piston for cracked ring lands, skirts or pin bosses, wavy worn ring lands, scuffed or damaged skirts or eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks or burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under "Piston Selection - Cylinder Block".

Piston Pins:

1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish or scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001" (.025mm) wear limit, replace piston and piston pin assembly.

Piston Rings:

All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston.

Oil control rings are a 3-piece type, consisting of 2 segments (rails) and a spacer.

1. Select rings comparable in size to piston being used.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about ¼" (6mm) (below ring travel). Be sure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge. (Figure 4)
4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons, if not previously done.
7. Slip outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around the groove (Figure 5) to make sure that ring is free. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, check a new ring.
8. Install piston ring as shown in Figure 6. Use 91-24697 piston ring expanders for compression ring installation.
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined and, if caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, check a new ring.
   e. Install lower compression ring, using ring expander, and check location of gap.
   f. Install top compression ring with gap properly located.

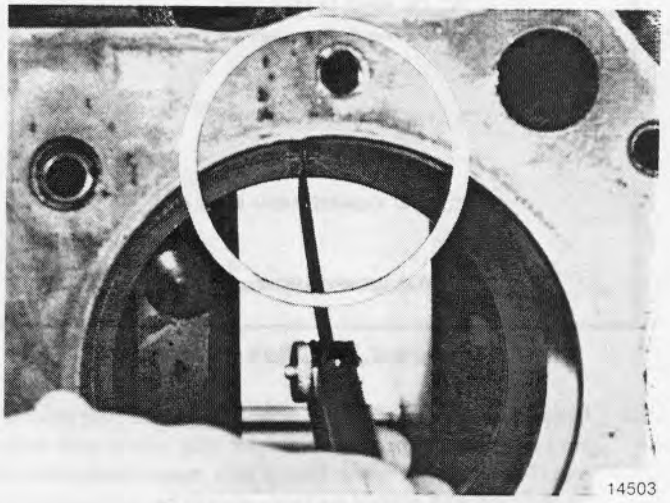


Figure 4. Checking Ring Gap

Figure 5. Rolling Ring in Ring Groove

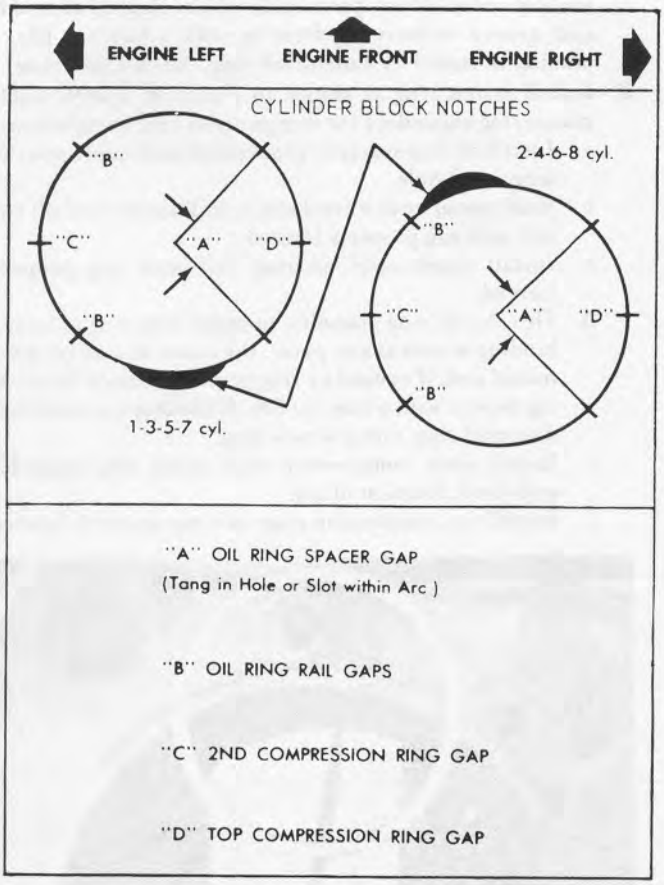


Figure 6. Ring Gap Location

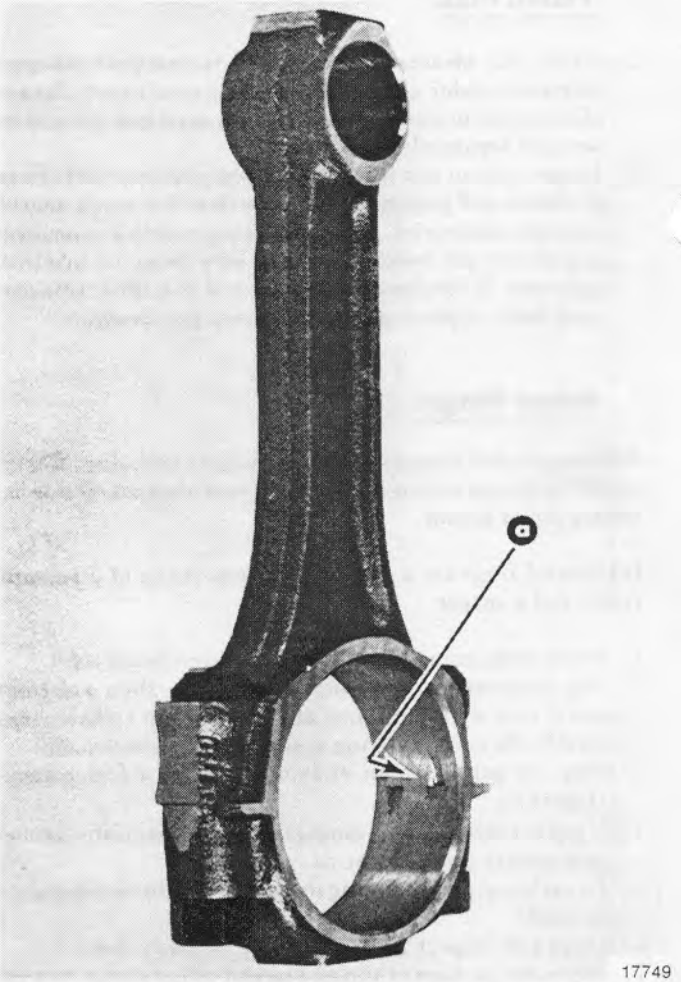
9. Proper clearance of piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. (Figure 7) See "Specifications".

Figure 7. Checking Groove Clearance

REASSEMBLY

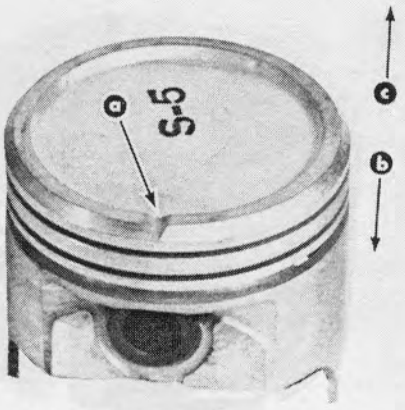
IMPORTANT: When reassembling pistons and connecting rods, the following MUST BE kept in mind.

- **Piston and pin are machine fitted to each other and must remain together as a matched set. DO NOT INTERMIX PISTONS AND PINS.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block. (Figure 8)**
- **Reference mark on piston, must be positioned correctly for engine that is being repaired. (Figures 9, 10, 11, 12, 13, 14, 15 or 16)**
- **To determine if engine is left-hand (standard) rotation or right-hand (opposite) rotation, inspect camshaft drive. If engine has a timing chain, engine is left-hand rotation. If engine has timing gears, engine is right-hand rotation. All MCM engines are left-hand rotation.**



a - Connecting Rod Bearing Tangs Must Face Toward Outside of Cylinder Block

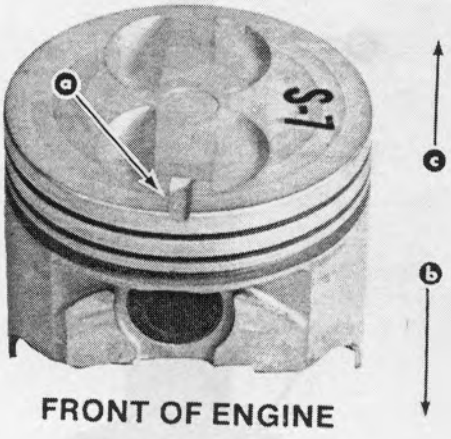
Figure 8. Connecting Rod



17758

a - Notch
b - MCM and MIE L.H. Rotation Engines - Notch Toward Front of Engine
c - MIE R.H. Rotation Engines - Notch Toward Rear of Engine

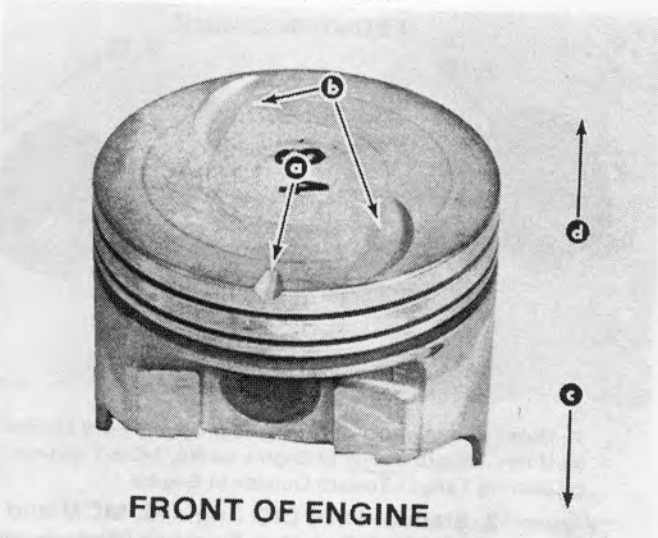
Figure 9. 305 CID Engines



17755

a - Notch
b - MCM and MIE L.H. Rotation Engines - Notch Toward Front of Engine
c - MIE R.H. Rotation Engines - Notch Toward Rear of Engine

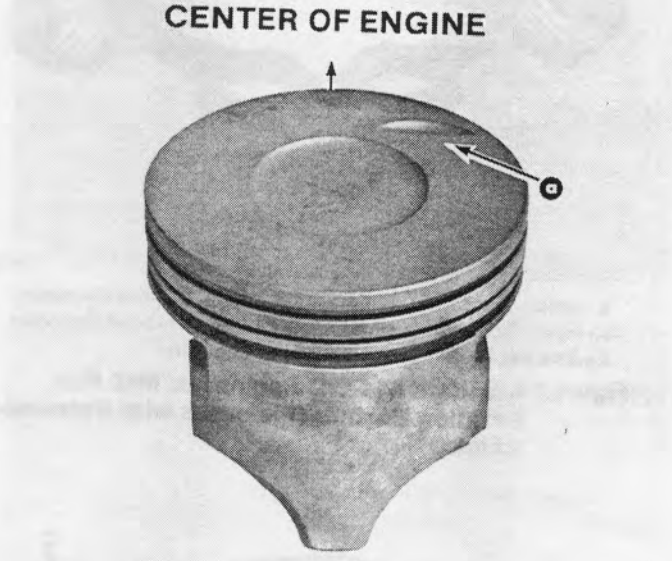
Figure 10. 350 CID Engines



17756

a - Notch
b - Valve Relief
c - MCM and MIE L.H. Rotation Engines - Notch Toward Front of Engine
d - MIE R.H. Rotation Engines - Notch Toward Rear of Engine

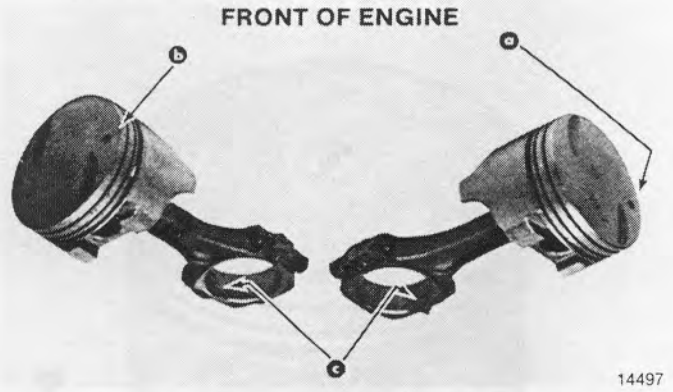
Figure 11. Standard 454 CID Engines



17754

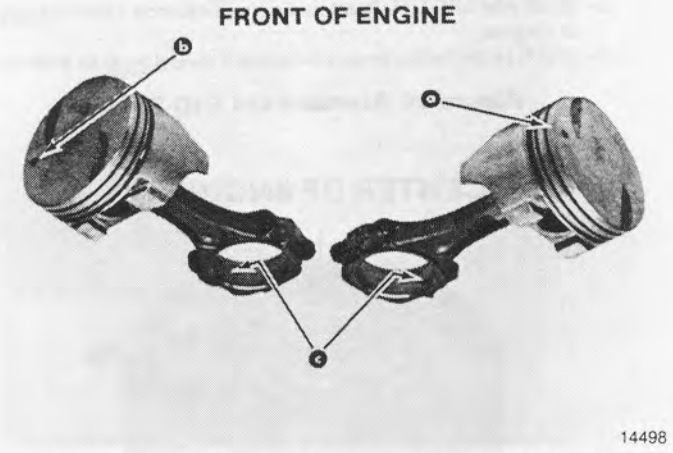
a - Valve-Relief - Toward Center of Engine on MCM, MIE L.H. or MIE R.H. Engines

Figure 12. Standard 454 CID Engines (Sumped Piston)



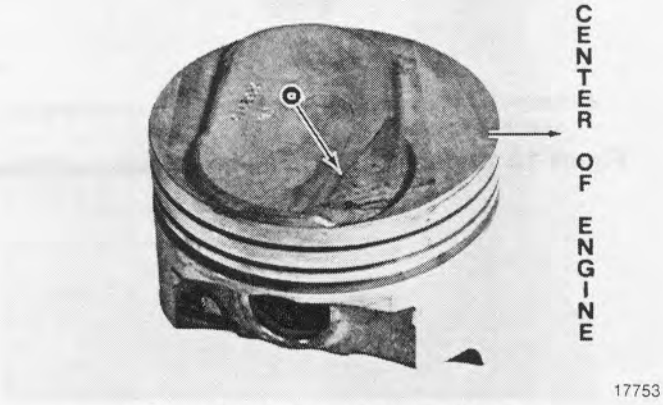
a - Hole - Toward Outside of Engine on No. 2-4-6-8 Cylinders
b - Hole - Toward Center of Engine on No. 1-3-5-7 Cylinders
c - Bearing Tangs - Toward Outside of Engine

Figure 13. Standard 454 CID Engines, MCM and MIE L.H. Rotation Engines (Pistons with Reference Hole)



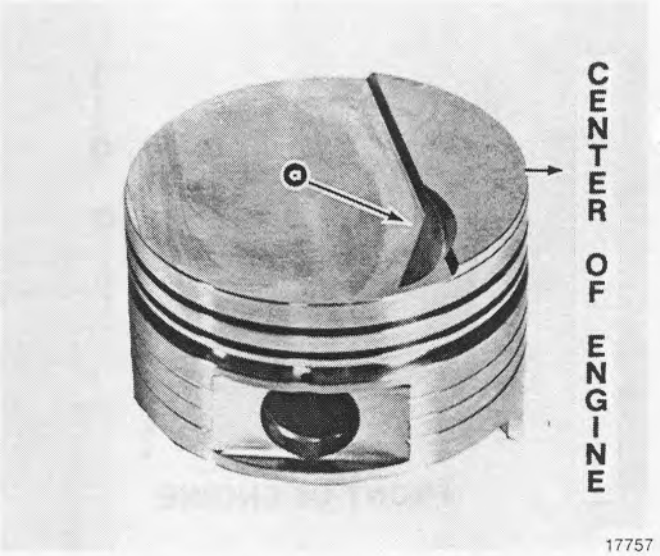
a - Hole - Toward Center of Engine on No. 2-4-6-8 Cylinders
b - Hole - Toward Outside of Engine on No. 1-3-5-7 Cylinders
c - Bearing Tangs - Toward Outside of Engine

Figure 14. Standard 454 CID Engines, MIE R.H. Rotation Engines (Pistons with Reference Hole)



a - Valve Relief - Toward Center of Engine

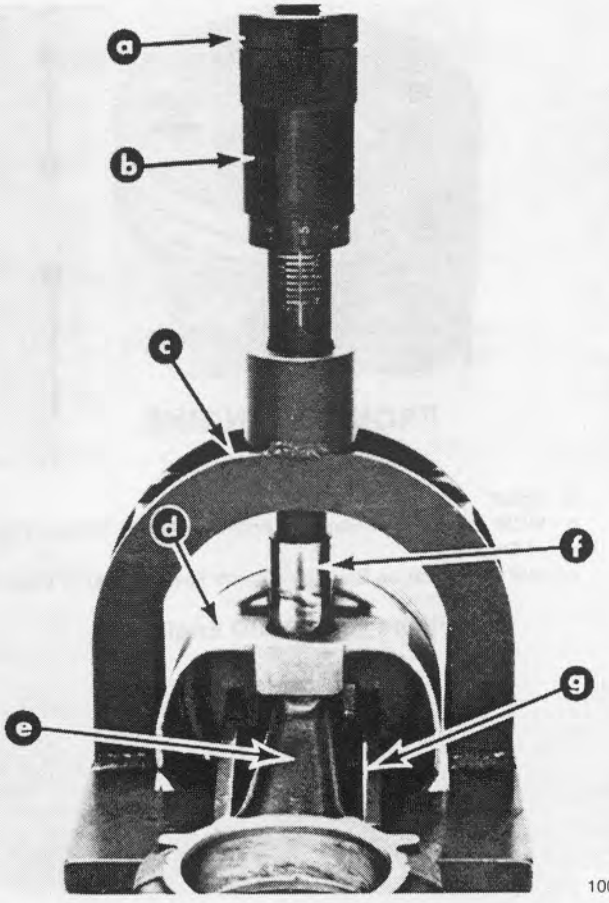
Figure 15. Hi-Performance 454 CID Engines



a - Valve Relief - Toward Center of Engine

Figure 16. Hi-Performance 454 CID Engine - 475 Turbo

1. Install piston pin with Tool Kit J-24086-100. (Figure 17) Refer to chart (furnished with Tool) and select proper size piston pin guide for specific engine being worked on.
2. Lubricate piston pin, piston pin hole in piston and hole in rod end with a light coat of engine oil.



a - Jam Nut
b - Adjustable Installer
c - Arched Base
d - Piston
e - Connecting Rod
f - Piston Pin
g - Rod Support

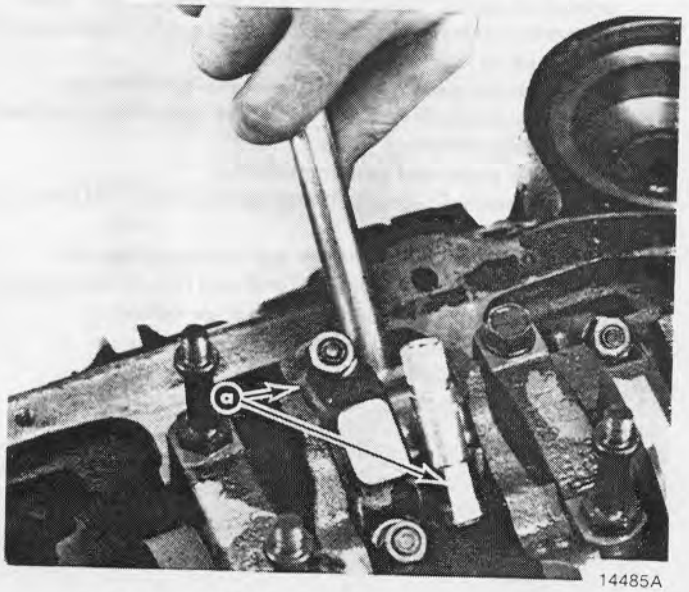
Figure 17. Installing Piston Pin

3. Position rod onto rod support and piston onto rod end. Insert piston pin guide thru bottom piston pin hole and into connecting rod. Place piston pin thru top side of piston. (Figure 17)
4. Adjust adjustable installer to setting specified on chart (which came with tool) for particular piston installation. Lock adjustable installer with jam nut.
5. Insert adjustable installer thru hole (located on top of arched base) and into piston pin hole. Carefully press on adjustable installer until installer bottoms-out on arched base to install piston pin.
6. Check piston for freedom of movement in piston pin bores by moving connecting rod back-and-forth and up-and-down. Connecting rod should move freely (with no resistance) in both directions. If it does not, piston pin is tight in piston pin bores and piston and pin assembly MUST BE replaced.
7. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

INSTALLATION

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install tool J-5239 (3/8") or J-6305-1 (11/32") on connecting rod bolts.



a - Connecting Rod Bearing Tangs Toward Outside of Cylinder Block

Figure 18. Connecting Rods - Installed Position

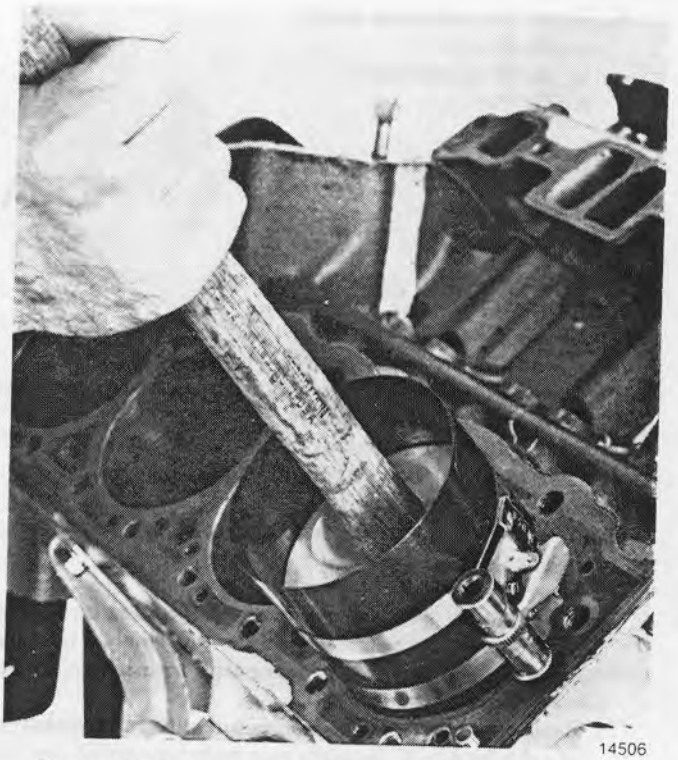


Figure 19. Installing Connecting Rod and Piston Assemblies

IMPORTANT: Be sure ring gaps are properly positioned as previously outlined.

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. (Figure 18) Use tool J-8307 to compress rings. (Figure 19) Guide connecting rod into place on crankshaft journal with tool J-5239 or J-6305-1. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.

5. Remove tool J-5239 or J-6305-1.
6. Install bearing caps and torque nuts to specification.
7. Check connecting rod side clearance.

NOTE: If bearing replacement is required, refer to "Connecting Rod Bearings".

8. Install the following items:
   a. Oil Pump
   b. Baffle (if equipped)
   c. Oil Pan
   d. Cylinder Head
9. Install engine in boat.
10. Fill crankcase with oil.
11. Start engine, adjust timing and check for leaks.

CRANKSHAFT

REMOVAL

1. Remove engine from boat.
2. Drain coolant and crankcase oil. Disconnect all hoses.
3. Remove starter motor, flywheel housing and flywheel. Place engine in repair stand.
4. Remove belts, crankshaft pulley and water pump.
5. Remove torsional damper and crankcase front cover.
6. Remove spark plugs.
7. Remove camshaft sprocket and timing chain. (Left-hand rotation engines only.)
8. Remove oil pan and oil pump.
9. Make sure all bearing caps (main and connecting rods) are marked so they can be installed in their original locations.
10. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
11. Remove main bearing caps and carefully lift crankshaft out of cylinder block. Remove rear main bearing oil seal from cylinder block and rear main bearing cap.
12. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined. (See "Index".)

CLEANING and INSPECTION

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see "Specifications").
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in "V" blocks) and check at front and rear intermediate journals with a dial indicator (see "Specifications").
4. Replace or recondition crankshaft if not meeting specifications.

INSTALLATION

1. If a new crankshaft is being installed, proceed as follows:
   a. Remove timing sprocket or gear from old crankshaft and reinstall on new crankshaft.
   b. **On I-Drive Engines:** Remove flywheel attaching studs from old crankshaft, using heat if necessary. Reinstall studs in new crankshaft with Loctite 35 applied to threads.
   c. **On Engines with a Mercury Marine Transmission:** Remove crankshaft pilot bushing by filling cavity in-behind bushing with grease, then, inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity which should force bushing out without damaging it. Reinstall bushing in new crankshaft using an appropriate driver.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

2. Install a new rear main bearing oil seal in cylinder block and rear main bearing cap.
3. Carefully lower crankshaft into place. BE CAREFUL not to damage bearing surface.
4. Check clearance of each main bearing, following procedure outlined under "Main Bearing"; see "Index". If bearing clearances are satisfactory, apply a light coat of engine oil to journals and bearings.
5. Install all bearing caps and bolts. Torque all main bearing cap bolts to specifications. When tightening rear main bearing cap. Follow procedure outlined under "Main Bearing"; see "Index".
6. Check clearance for each connecting rod bearing, following procedure under "Connecting Rod Bearings"; see "Index". If bearing clearances are satisfactory, apply a light coat of engine oil to journals and bearings.
7. Install all rod caps and torque nuts to specifications.
8. Check crankshaft end play. Follow procedure outlined under "Main Bearing"; see "Index".
9. Install oil pump and pan as outlined.
10. Install camshaft sprocket and timing chain. (Left-hand rotation engines only.)
11. Install crankcase front cover and torsional damper.
12. Remove engine from repair stand and install water pump, flywheel, flywheel housing and starter motor.
13. Install crankshaft pulley and belts.
14. Install spark plugs.
15. Install engine in boat, fill crankcase and install hoses.

CRANKSHAFT SPROCKET/GEAR

REMOVAL

1. Remove torsional damper and crankcase front cover as outlined.
2. Remove camshaft timing chain as outlined.
3. Using tool shown in chart, remove sprocket or gear. (Figure 1 or 2)

MCM, MIE L.H. ROT., MIE R.H. ROT. 305/ 350 CID ENGINE	J-1619 (Figure 1)
MIE R.H. ROT. 454 CID ENGINE	J-8105 (Figure 2)

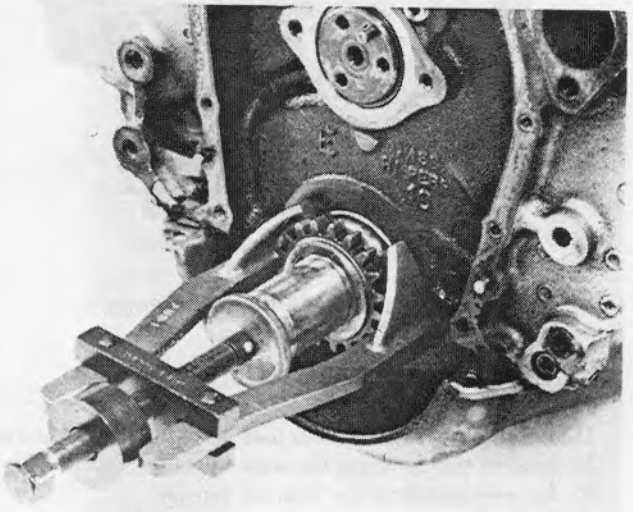


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Figure 1. J-1619 Puller

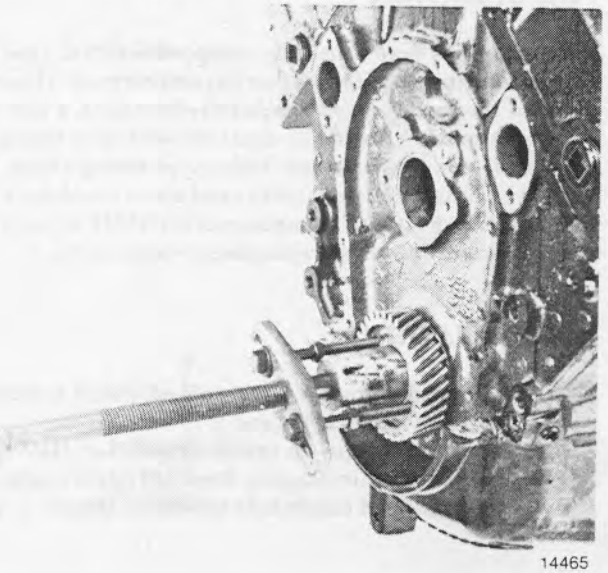

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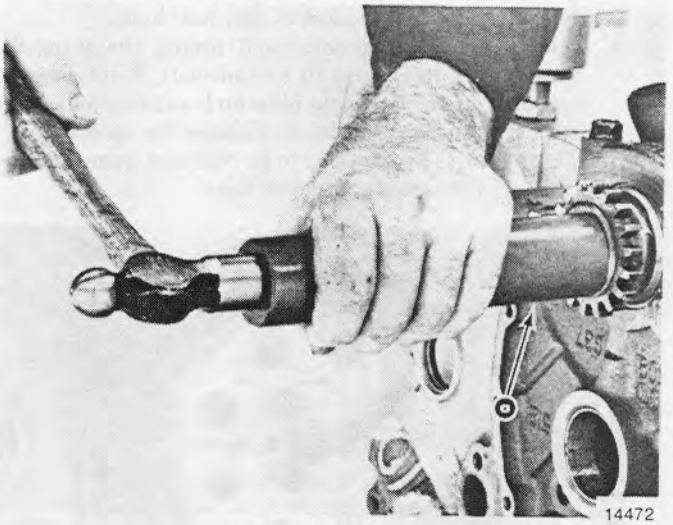
Figure 2. J-8105 Puller

INSTALLATION

1. Using correct tool as shown in Figure 3 or 4, install sprocket or gear.
2. Install camshaft timing chain as outlined.
3. Install crankcase front cover and torsional damper as outlined.



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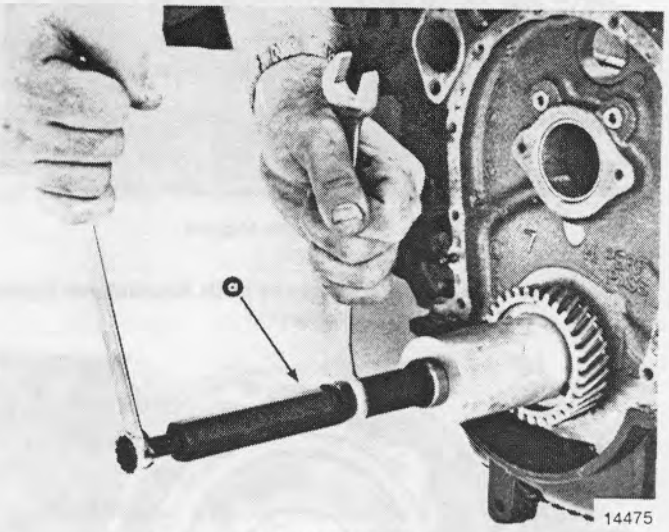
a - Tool J-5590

Figure 3. 305/350 CID Engines



14475

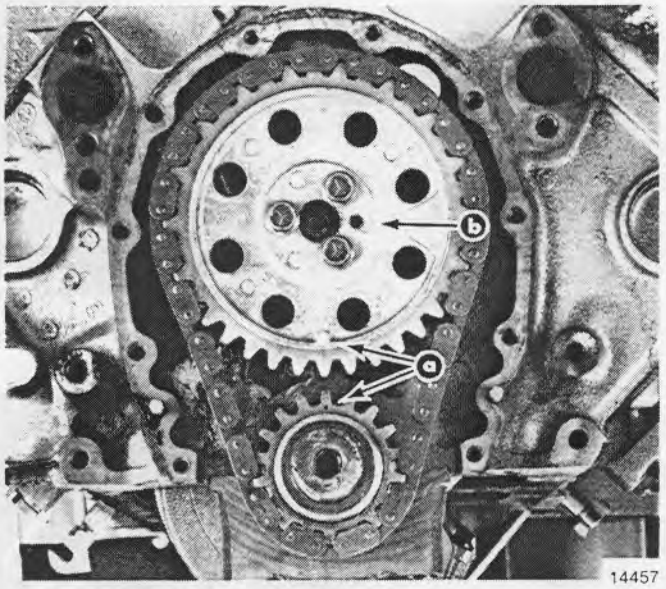
a - Tool J-21058-20

Figure 4. 454 CID Engines

TIMING CHAIN/SPROCKETS
LEFT-HAND (STANDARD) ROTATION ENGINES

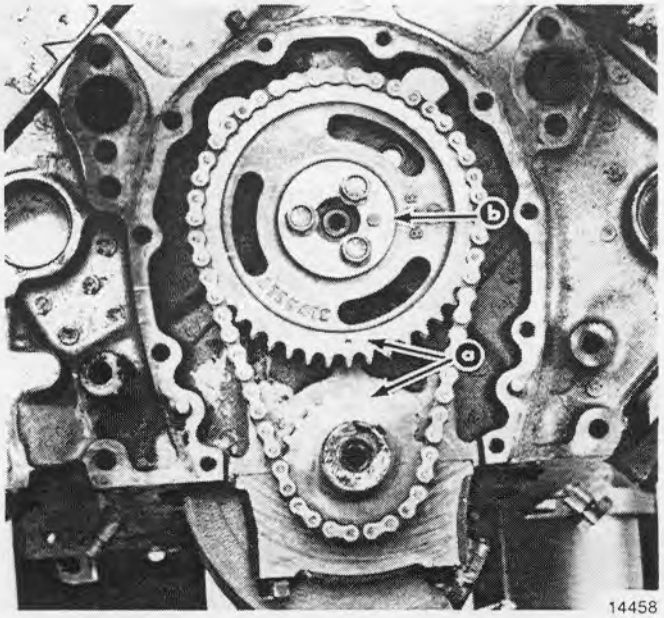
REMOVAL

1. Remove torsional damper and crankcase front cover as outlined.
2. Crank engine until marks on camshaft and crankshaft sprockets are in alignment. (Figure 1, 2 or 3)
3. Remove camshaft sprocket to camshaft bolts.
4. Remove camshaft sprocket and timing chain together. Sprocket is a light press fit on camshaft. If sprocket does not come off easily, a light blow on lower edge of sprocket (with a plastic mallet) should dislodge the sprocket.
5. If crankshaft sprocket has to be replaced, remove as outlined in "Crankshaft Sprocket/Gear".



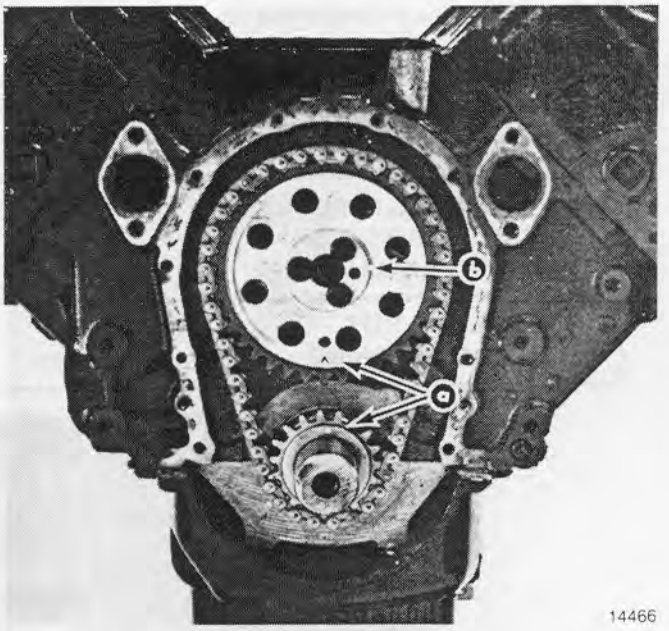
a - Timing Marks Aligned
b - Locating Pin

Figure 1. 305/350 CID Engines with Aluminum/Nylon Camshaft Sprocket



a - Timing Marks Aligned
b - Locating Pin

Figure 2. 305/350 CID Engines with All Metal Camshaft Sprocket



a - Timing Marks Aligned
b - Locating Pin

Figure 3. 454 CID Engines

CLEANING and INSPECTION

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear or damage.
3. Inspect sprockets for wear or damage.

305/350 CID ENGINE REPLACEMENT PART INFORMATION

Some engines were originally equipped with link type timing chain and timing sprockets that have nylon teeth. (Figure 1) If any of these components require replacement, a new timing chain assembly (35378A1) must be used. The timing chain assembly consists of a new roller type timing chain, an all-metal camshaft timing sprocket and a new crankshaft timing sprocket. The original components CANNOT be used in any combination with these replacement components.

INSTALLATION

1. If crankshaft sprocket was removed, install as outlined in "Crankshaft Sprocket/Gear".
2. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down and orient to align marks on camshaft and crankshaft sprockets. (Figure 1, 2 or 3)

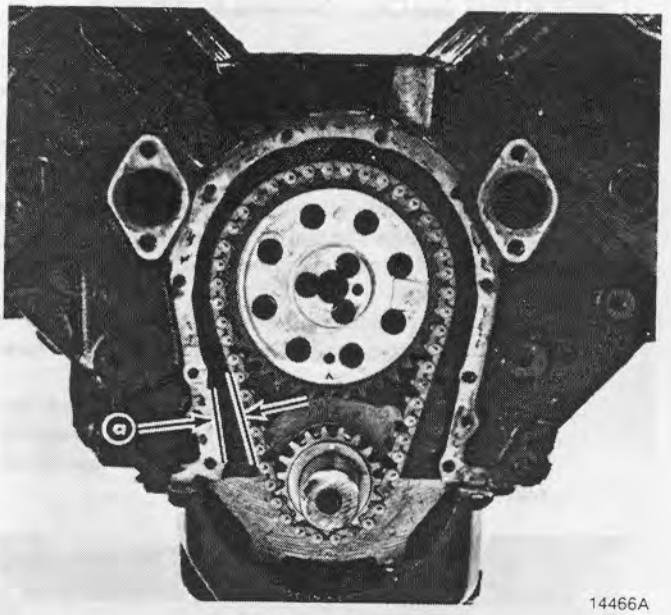
IMPORTANT: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

3. Draw camshaft sprocket onto camshaft, using the 3 mounting bolts. Torque to specifications.
4. Lubricate timing chain with engine oil. Install crankcase front cover and torsional damper as outlined.

CHECKING TIMING CHAIN DEFLECTION

With timing chain and sprockets installed, check timing chain deflection, as follows: (Figure 4)

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
4. The deflection is the difference between these two measurements. If the deflection exceeds specifications, timing chain should be replaced.



a - Reference Point

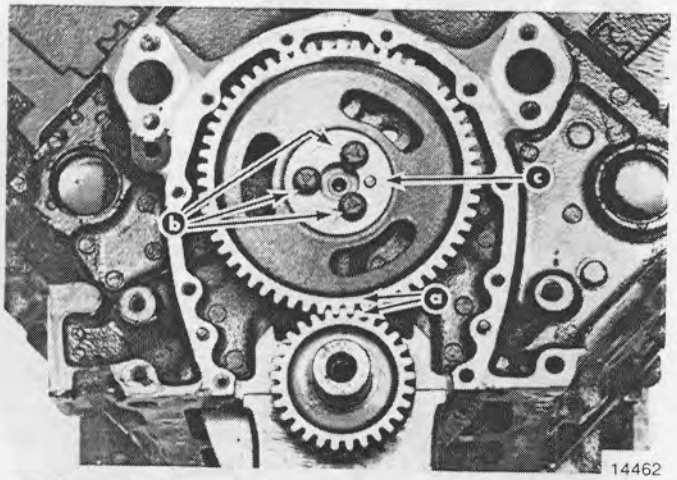
Figure 4. Checking Timing Chain Deflection

TIMING GEARS
RIGHT-HAND (OPPOSITE) ROTATION ENGINES

305/350 CID ENGINES:

REMOVAL

1. Remove oil pan, torsional damper and crankcase front cover as outlined.
2. Crank engine over until timing mark on camshaft timing gear aligns with timing mark on crankshaft timing gear. (Figure 1)



a - Timing Marks b - Screws c - Locating Pin

Figure 1. Timing Marks Aligned

3. Remove camshaft timing gear attaching screws (and washers if so equipped) (Figure 1) and remove gear. If gear does not come off easily, a LIGHT blow on the lower edge of the gear with a plastic mallet should dislodge the gear.
4. If crankshaft timing gear requires replacement, remove as outlined in "Crankshaft Sprocket/Gear" (see "Index").

CLEANING and INSPECTION

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing gears for worn or damaged teeth.
3. Inspect camshaft gear to cylinder block contact surfaces for damage.

INSTALLATION

1. If removed, install crankshaft timing gear as outlined in "Crankshaft Sprocket/Gear".
2. Position camshaft timing gear so that timing mark aligns with timing mark on crankshaft timing gear, then align camshaft dowel with hole in camshaft gear and install gear on camshaft. (Figure 1)
3. Install 3 camshaft timing gear attaching screws (and washers if so equipped) and draw sprocket onto camshaft. After sprocket is in place, torque screws to specifications.

IMPORTANT: Do not attempt to drive gear on camshaft, as welsh plug at rear of engine can be dislodged.

4. Check timing gear backlash and runout as explained under "Checking Backlash and Runout".
5. Lubricate timing gears with engine oil.
6. Install crankcase front cover, oil pan and torsional damper as explained.

CHECKING BACKLASH and RUNOUT

1. Remove fuel pump and fuel pump push rod.
2. Loosen rocker arm nuts (to relieve tension on hydraulic valve lifters).
3. With timing gears installed, check camshaft to crankshaft gear backlash, as follows: (Figure 2)
   a. Mount a dial indicator on engine so that indicator stem contacts one of the teeth on camshaft gear. Indicator stem should be as perpendicular to gear tooth surface as possible.
   b. Check the backlash between the camshaft gear and crankshaft gear while applying inward pressure on camshaft gear.
   c. If backlash is not within specifications, check for improperly machined parts or for worn camshaft or crankshaft bearings. If bearings check out good, replace BOTH timing gears.

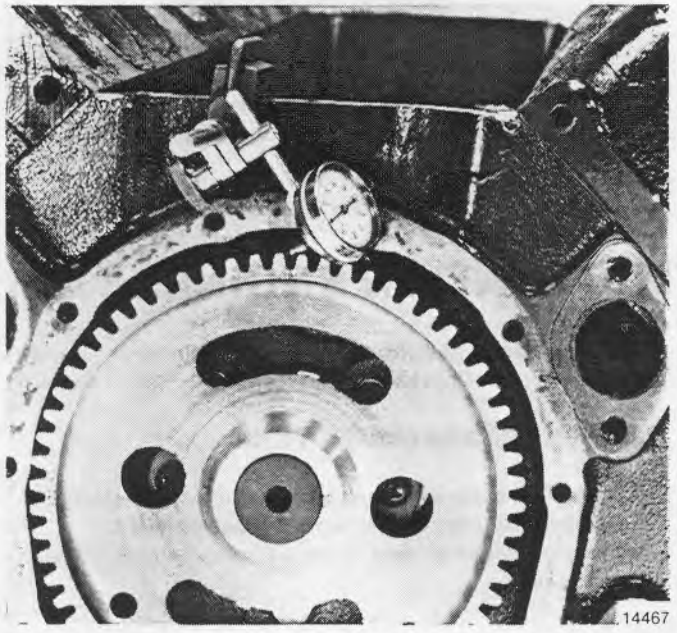
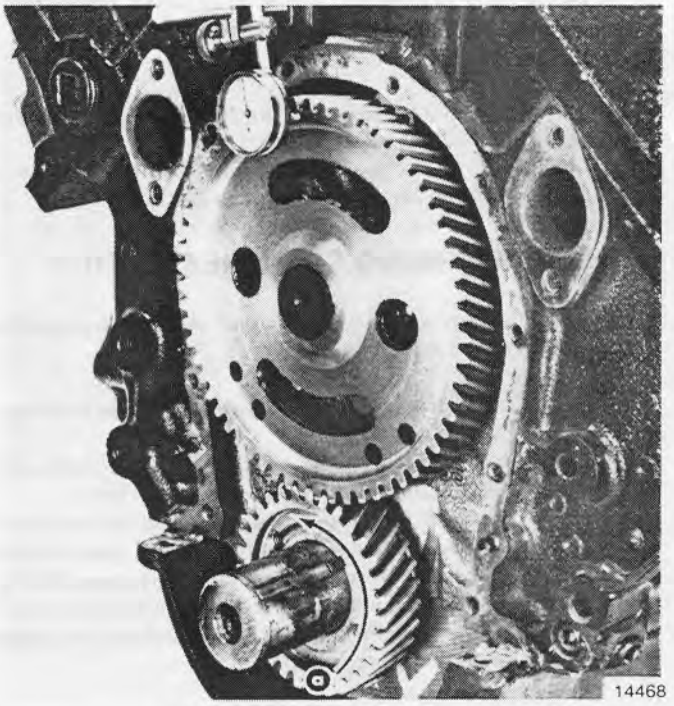


Figure 2. Checking Backlash

4. With timing gear installed, check camshaft and crankshaft timing gear runout, as follows:
   a. Mount dial indicator on block so that indicator stem is perpendicular to camshaft timing gear and contacts gear surface just adjacent to teeth. (Figure 3)
   b. Apply inward pressure on timing gear and zero indicator, then turn crankshaft as shown. (Figure 3) Check gear runout through one complete revolution of camshaft gear.
   c. If not within specifications, check for burrs or foreign material between gear and camshaft joining surfaces. If none is found, replace BOTH timing gears.
   d. Check crankshaft timing gear runout in same manner. Runout should not exceed specifications. Replace BOTH gears, if runout is excessive.
5. Adjust rocker arm nuts.
6. Install fuel pump push rod and fuel pump.



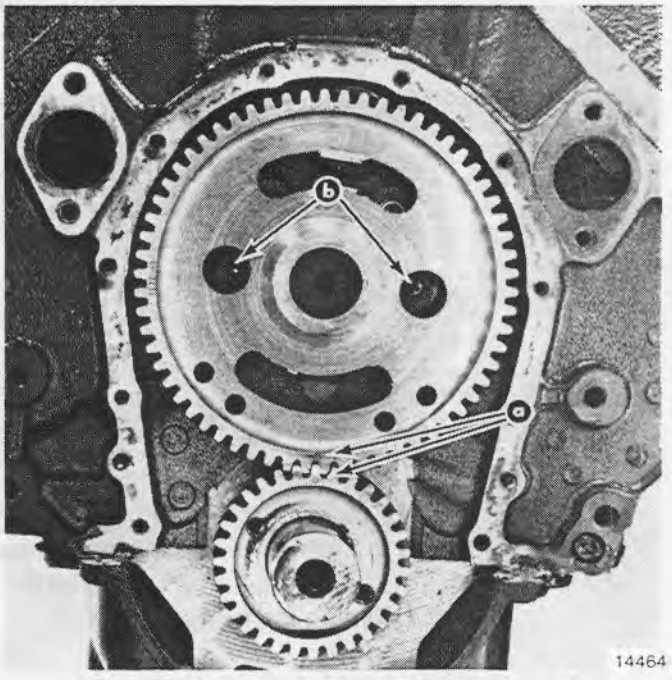
a - Turn Crankshaft In This Direction

Figure 3. Checking Gear Runout

454/482 CID ENGINES:

REMOVAL

1. Remove crankcase front cover.
2. Crank engine over until timing mark on camshaft gear aligns with timing mark on crankshaft timing gear. (Figure 4)



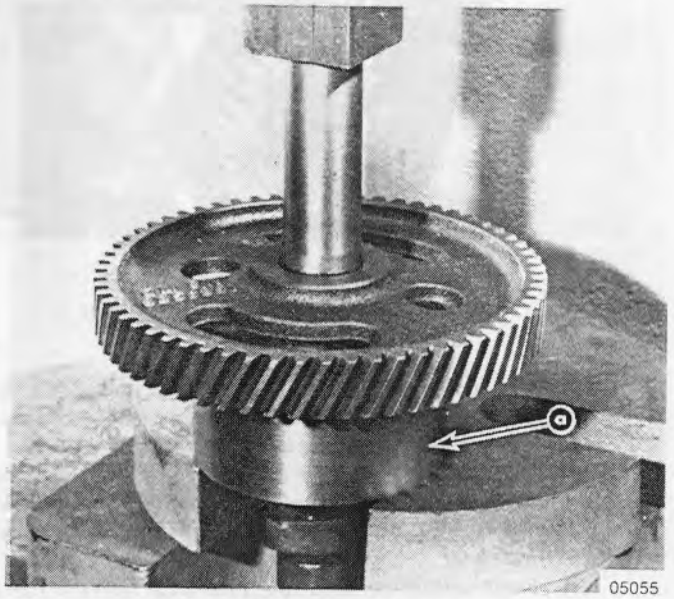
a - Timing Marks b - Thrust Plate Attaching Screws

Figure 4. Timing Marks Aligned

3. Remove camshaft thrust plate attaching screws through holes in timing gear. (Figure 4)

IMPORTANT: Use extreme care when removing camshaft (in next step) to prevent damaging camshaft bearings. All camshaft journals are the same size.

4. To remove camshaft and gear as an assembly, refer to "Camshaft" (see "Index").
5. If camshaft, timing gear or thrust plate requires replacement, press gear off of camshaft, using an arbor press and appropriate tools as shown in Figure 5. Be sure to use a support under gear to prevent pressing on thrust plate. If camshaft is to be replaced, remove (and discard) woodruff key from camshaft and remove spacer ring.



a - Support (Must Clear Thrust Plate)

Figure 5. Removing Camshaft Gear

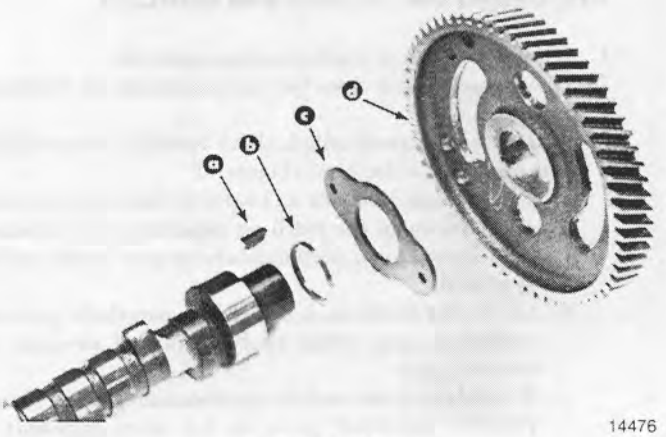
6. If crankshaft timing gear requires replacement, remove as outlined in "Crankshaft Sprocket/Gear", (see "Index").

CLEANING and INSPECTION

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing gears for worn or damaged teeth.

INSTALLATION

1. If removed, install crankshaft timing gear as outlined in "Crankshaft Sprocket/Gear".
2. If removed, install spacer ring, woodruff key, thrust plate and timing gear on camshaft, as follows: (Figure 6)
   a. Check mating surface on camshaft and timing gear to ensure that they are clean and free of burrs.
   b. Install spacer on camshaft with chamferred side toward camshaft.
   c. Install new woodruff key.
   d. Place thrust plate on end of camshaft with grooved side outward.
   e. Firmly support camshaft at back of front journal in an arbor press and press timing gear onto camshaft with timing mark outward.



a - Woodruff Key
b - Spacer Ring
c - Thrust Plate
d - Timing Gear

Figure 6. Installing Camshaft Timing Gear and Related Parts

   f. Check camshaft front journal to thrust plate clearance (end play) with feeler gauge. (Figure 7) If clearance is not as specified, make sure gear is pressed on all the way. Also check thrust plate and camshaft for excessive wear and replace as required.
3. Lubricate camshaft journals with engine oil and install camshaft being sure to align timing marks. (Figure 4)
4. Install thrust plate attaching screws and torque to specifications.
5. Check timing gear backlash and runout as explained under "Checking Backlash and Runout".
6. Lubricate timing gears with engine oil.
7. Install crankcase front cover and torsional damper, as explained.
8. Install hydraulic valve lifters, push rods, rocker arms and rocker arm covers as previously explained.

Figure 7. Checking End Play

CHECKING BACKLASH and RUNOUT

1. Remove fuel pump and fuel pump push rod.
2. Loosen rocker arm nuts (to relieve tension on hydraulic valve lifters).
3. With timing gears installed, check camshaft to crankshaft gear backlash, as follows: (Figure 8)
   a. Mount a dial indicator on engine so that indicator stem contacts one of the teeth on camshaft gear. Indicator stem should be as perpendicular to gear tooth surface as possible.
   b. Check the backlash between the camshaft gear and crankshaft gear while applying inward pressure on camshaft gear.
   c. If backlash is not within specifications, check for improperly machined parts or for worn camshaft or crankshaft bearings. If bearings check out good, replace BOTH timing gears.

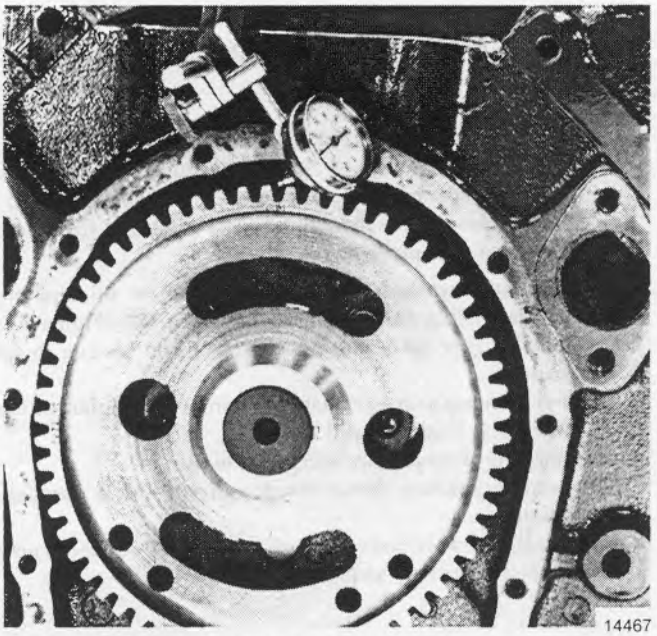
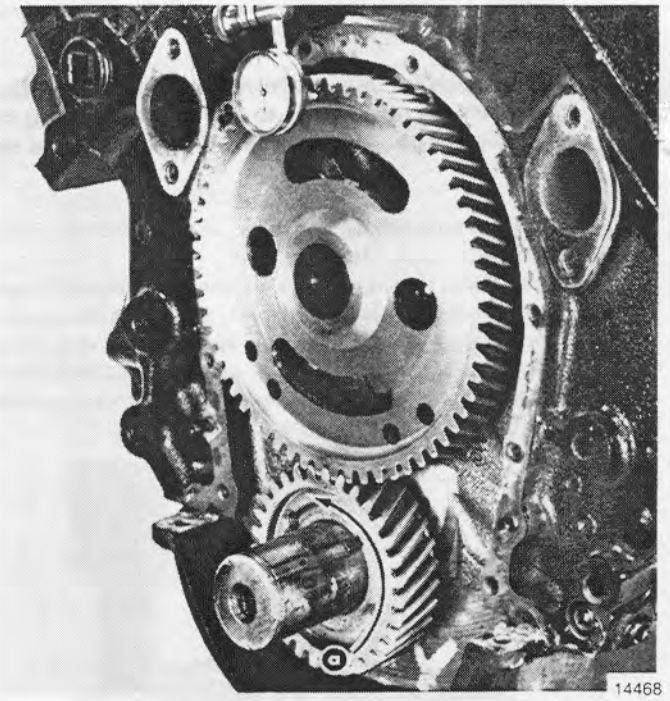


Figure 8. Checking Backlash

4. With timing gear installed, check camshaft and crankshaft timing gear runout, as follows:



a - Turn Crankshaft In This Direction

Figure 9. Checking Gear Runout

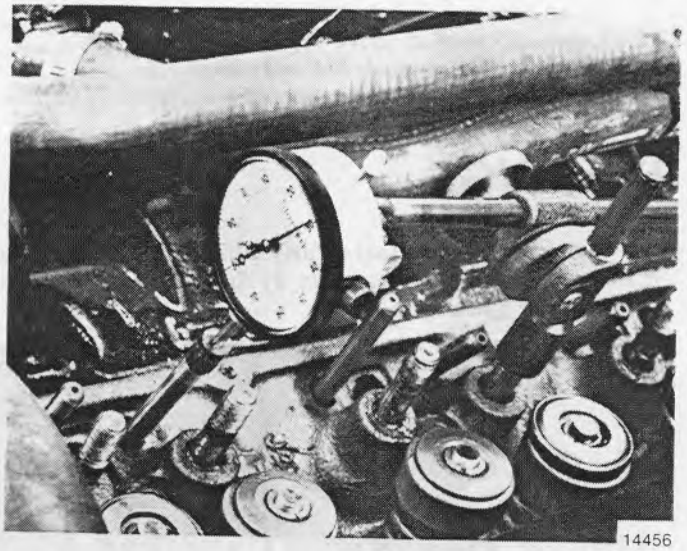
   a. Mount dial indicator on block so that indicator stem is perpendicular to camshaft timing gear and contacts gear surface just adjacent to teeth. (Figure 9)
   b. Apply outward pressure on timing gear and zero indicator, then turn crankshaft as shown. (Figure 9) Check gear runout through one complete revolution of camshaft gear.
   c. If not within specification, check for burrs or foreign material between gear and camshaft joining surfaces. If none is found, replace BOTH timing gears.
   d. Check crankshaft timing gear runout in same manner. Runout should not exceed specifications. Replace BOTH gears, if runout is excessive.
5. Adjust rocker arms.
6. Install fuel pump push rod and fuel pump.

CAMSHAFT

MEASURING LOBE LIFT

NOTE: Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.

1. Remove valve mechanism as outlined.
2. Position indicator with ball socket adapter Tool J-8520-1 on push rod. (Figure 1) Be sure that push rod is in lifter socket.



14456

Figure 1. Measuring Camshaft Lobe Lift

3. Rotate crankshaft damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and "bump" engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with "Specifications".
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism as outlined.

REMOVAL

1. Remove valve lifters as outlined.
2. Remove crankcase front cover as outlined.
3. Remove fuel pump and fuel pump push rod.
4. Remove camshaft as follows:

MCM and MIE L.H. Rotation Engines:

a. Refer to "Timing Chain/Sprockets, Left-Hand (Standard) Rotation Engines" to remove chain and sprocket.
b. Install two 5/16-18 bolts in camshaft sprocket bolt holes and carefully remove camshaft. (Figure 2)

14459

Figure 2. Removing Camshaft

MIE R.H. Rotation 305 and 350 CID Engines:

a. Refer to "Timing Gears, Right-Hand (Opposite) Rotation Engines" to remove timing gear.
b. Install two 5/16-18 bolts in camshaft gear bolt holes and carefully remove camshaft. (Figure 2)

MIE R.H. Rotation 454 CID Engines:

a. Refer to "Timing Gears, Right-Hand (Opposite) Rotation Engines" to remove thrust plate attaching screws.
b. Carefully remove camshaft and timing gear.
c. Remove timing gear as outlined.

INSPECTION

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001" (.025mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with "V" blocks and dial indicator (Figure 3) which indicates exact amount camshaft is out-of-true. If out more than .002" (.051mm) (dial indicator reading) camshaft should be replaced.

On engines with timing gears, inspect camshaft gear and thrust plate for wear or damage.

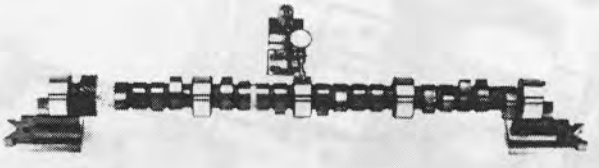


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Figure 3. Checking Camshaft Alignment

INSTALLATION

1. Install camshaft as follows:

MCM and MIE L.H. Rotation Engines:

a. Install two 5/16-18 bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft, being careful not to damage bearings. (Figure 2) Remove the two 5/16-18 bolts.

b. Install timing chain and sprocket as outlined in "Timing Chain/Sprockets, Left-Hand (Standard) Rotation Engines".

MIE R.H. Rotation 305 and 350 CID Engines:

a. Install two 5/16-18 bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft, being careful not to damage bearings. (Figure 2) Remove the two 5/16-18 bolts.

b. Install timing gear as outlined in "Timing Gears, Right-Hand (Opposite) Rotation Engines".

MIE R.H. Rotation 454 CID Engines:

a. If removed, press timing gear onto camshaft as outlined in "Timing Gears, Right-Hand (Opposite) Rotation Engines".

b. Lubricate camshaft journals with engine oil and install camshaft and timing gear, as outlined, being careful not to damage bearings.

2. Lubricate camshaft drive system with engine oil.
3. Install fuel pump push rod and fuel pump.
4. Install crankcase front cover and valve lifters as outlined.

CAMSHAFT BEARINGS

REMOVAL

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rod against sides of engine so that they will not interfere while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

   NOTE: This procedure is based on removal of bearings center of engine first, thus requiring a minimum amount of turns to remove all bearings.

2. Using tool set J-6098-01 (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
3. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
4. Using 2 wrenches, hold puller screw while turning nut. (Figure 1) When bearing has been pulled from bore, remove tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in same manner. It will be necessary to position pilot in rear camshaft bearing to remove rear intermediate bearing.

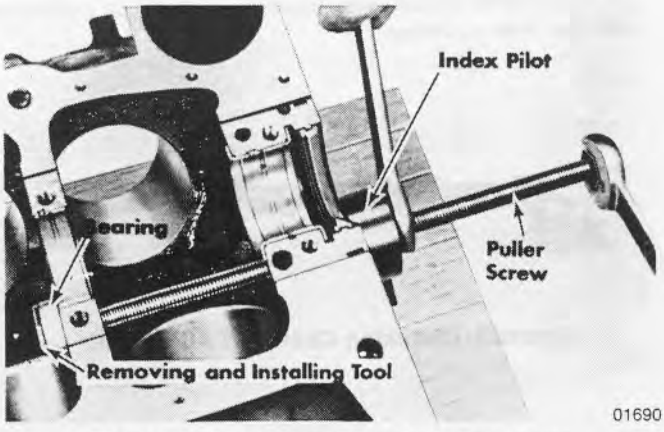


Figure 1. Replacing Camshaft Bearings

6. Assemble remover tool on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block. (Figure 2)

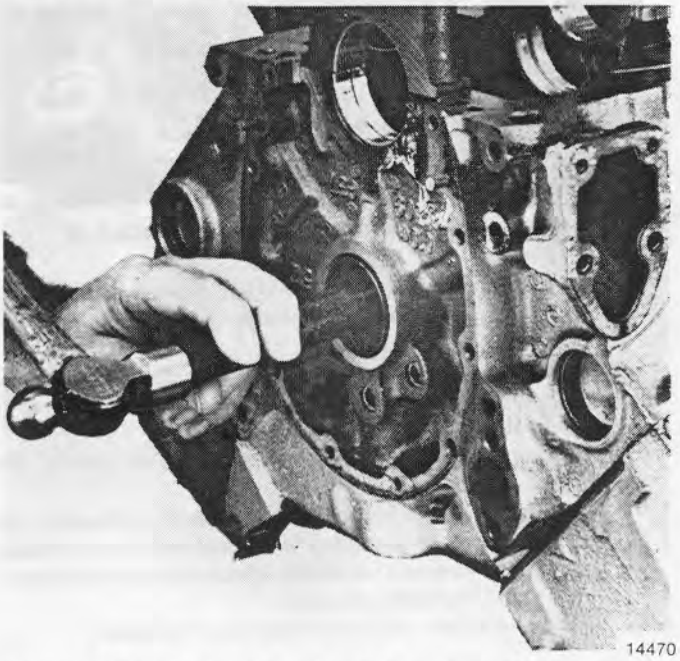


Figure 2. Replacing Front and Rear Camshaft Bearings

INSPECTION

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

INSTALLATION

305/350 CID Engines: Front and rear bearings MUST BE installed last as pilot will not fit into bearing bores if bearings are installed.

454 CID Engines: Front and rear bearings should be installed first to act as a guide to center pilot when installing center and intermediate bearings.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearing in proper location (indicated by bearing manufacturer) and to position bearings as follows: (Directional references are in reference to engine in its normal operating position.)

- **305 and 350 CID Engines: Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.**
- **454 CID Engine: Front, Intermediate and Center camshaft bearings must be installed so that oil hole in each aligns with oil hole in block. Rear bearing bore is grooved and bearing oil hole must be positioned at or near the 6 o'clock position.**

1. Installing Intermediate and Center Bearings: (Figure 1)
   a. Install nut and thrust washer all-the-way onto puller screw, then position pilot in front camshaft bearing bore and insert screw thru pilot.
   b. Index center camshaft bearing, then position appropriate size remover and installer tool in bearing and thread puller screw into tool. Be sure at least ½" (13mm) of threads are engaged.
   c. Using 2 wrenches, hold puller screw and turn nut until bearing has been pulled into position. Remove the remover and installer tool and check to ensure that oil hole(s) in bearing are positioned correctly.
   d. Install intermediate bearings in same manner being sure to index bearings correctly. It will be necessary to position pilot in rear camshaft bearing bore to install rear intermediate bearing.
2. Installing Front and Rear Bearings: (Figure 2)
   a. Install appropriate size remover and installer tool on drive handle.
   b. Index front bearing (as explained in "Important"), and drive it into position with tool. Check position of oil hole(s) in bearing to ensure bearing is positioned correctly.
   c. Install rear bearing in same manner, being sure to index bearing correctly.
3. Install a new camshaft rear plug.

   IMPORTANT: Plug must be installed flush to 1/32" (.8mm) deep and must be parallel with rear surface of cylinder block.

4. Install crankshaft and camshaft as outlined.

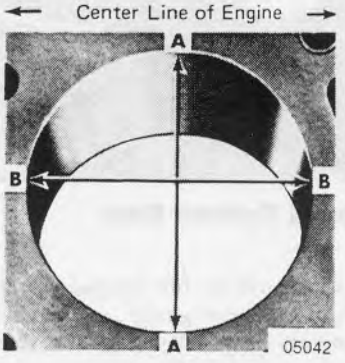
CYLINDER BLOCK

CLEANING and INSPECTION

1. Remove all engine components as previously outlined.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.

   NOTE: These plugs may be removed with a sharp punch, or they may be drilled and pried out.

4. Clean and inspect water passages in cylinder block.
5. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
6. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. (Figure 1) This should be done with a dial indicator or inside micrometer. (Figures 2 and 3) Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



"A" = At right angle to centerline of engine
"B" = Parallel to centerline of engine
"Out-of-round" = Difference between "A" and "B"
"Taper" = Difference between measurement "A" at top of cylinder bore and "A" measurement at bottom of cylinder bore.

Figure 1. Cylinder Measurement

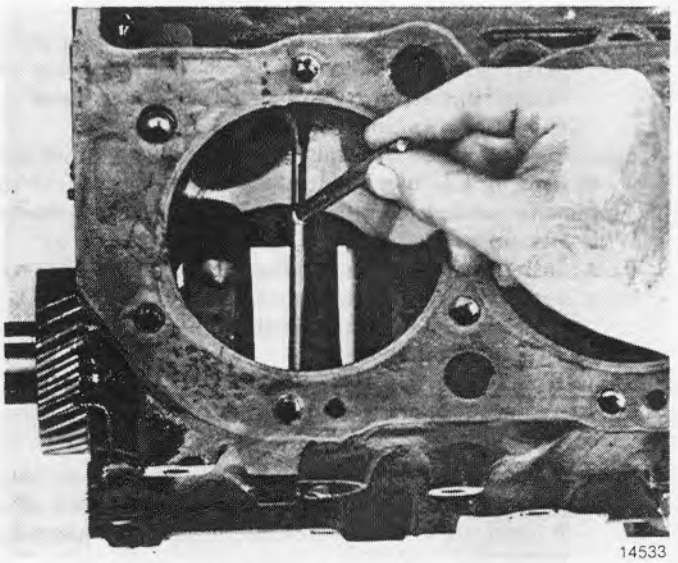


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Figure 2. Measuring Cylinder Bore

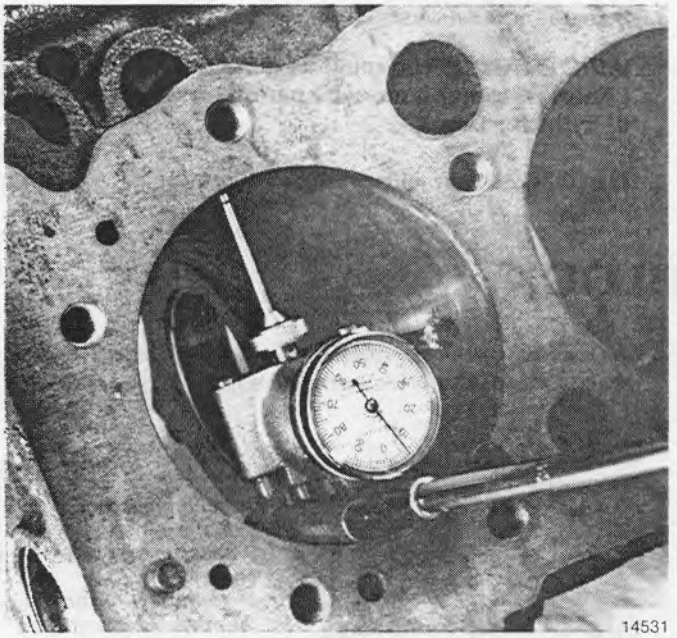

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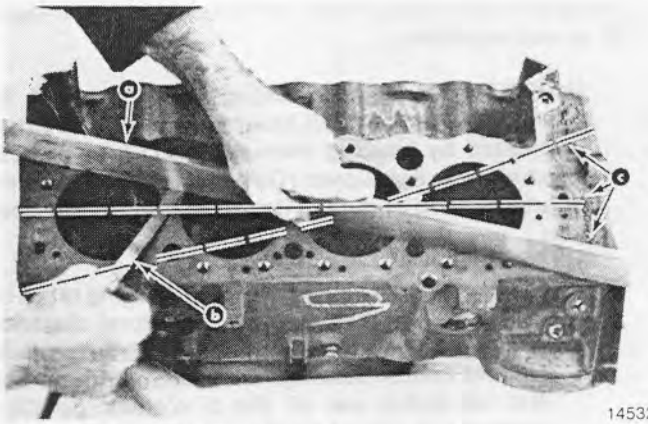
Figure 3. Measuring Cylinder Bore

7. Check cylinder head gasket surfaces for warpage with a machinists straight edge and a feeler gauge, as shown in Figure 4. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are out-of-flat more than .003″ (.07mm) in a 6″ area or .007″ (.2mm) overall, block must be resurfaced by an automotive machine shop.



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a - Machinists Straight Edge
b - Feeler Gauge
c - Take Measurements Diagonally Across Surface and Straight Down Center

Figure 4. Checking Cylinder Head Gasket Surfaces for Warpage

REPAIRS

CYLINDER CONDITIONING:

1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005″ (.127mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of less than .005″ wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to rebore for an oversize piston. If more than .005″ taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING:

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt, with result that rebored cylinder wall is not at right angles to crankshaft.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection", following.

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING:

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up-and-down at a sufficient speed to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 30° to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION:

1. Check USED piston to cylinder bore clearance as follows:
   a. Measure "cylinder bore diameter" with a telescope gauge 2½" (64mm) from top of cylinder bore. (Figure 5)
   b. Measure "piston diameter" at skirt across center line of piston pin. (Figure 6)
   c. Subtract piston diameter from cylinder bore diameter to determine "piston-to-bore clearance".
   d. Determine if "piston-to-bore clearance" is in acceptable range shown in "Specifications".
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.

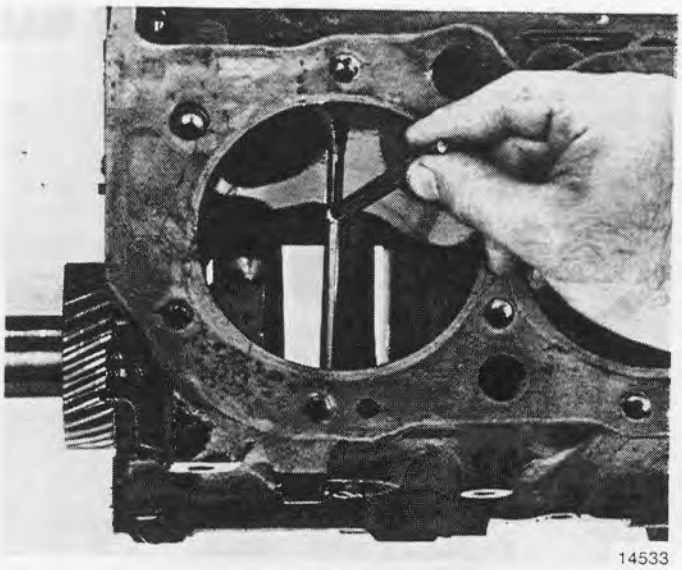

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Figure 5. Measuring Cylinder Bore

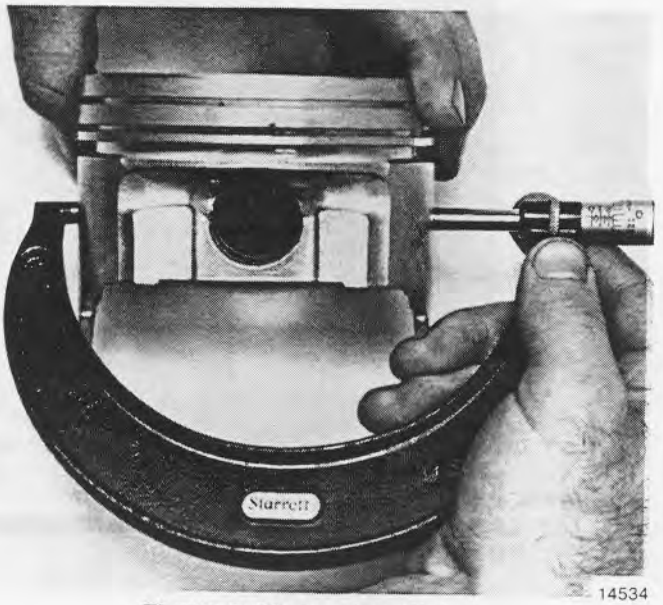

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Figure 6. Measuring Piston

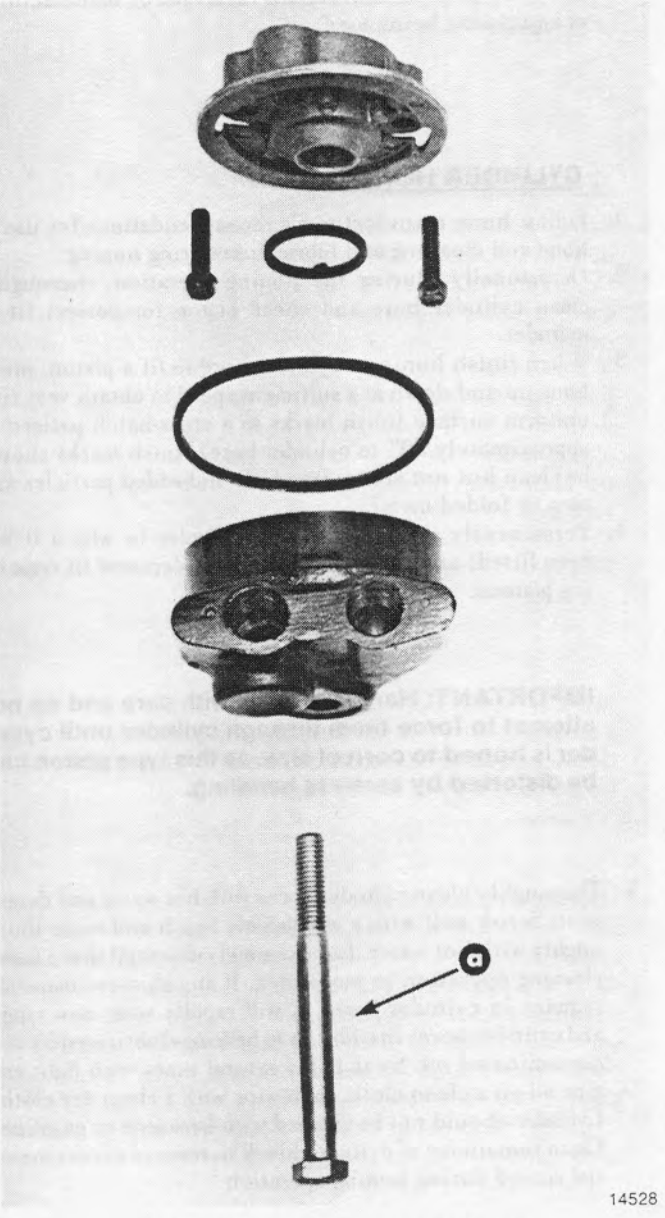
REPLACEMENT PART INFORMATION

If replacement of cylinder block is necessary, the following must be performed:

1. Retain double-ended main bearing cap attaching screws (used to support oil splash plate) for use with new engine. New engines are shipped with regular (single-ended) bolts only.
2. Retain oil filter by-pass valve and adaptor assembly and related parts for use with new engines.
3. If engine being replaced has a remote oil filter, check the cylinder block being replaced to determine method used to attach cylinder block adaptor to cylinder block. Refer to Figures 2 and 3 under "Oil Filter By-Pass Valve and Adaptor Assembly". If it uses the older style adaptor that is secured to the block with one ½-13 bolt, a Remote Oil Filter Adaptor Kit (90783A9) is required to adapt the remote oil filter to new block. All new blocks are machined to accept new style oil hoses to cylinder block adaptor which is secured to block with two 5/16-18 screws.

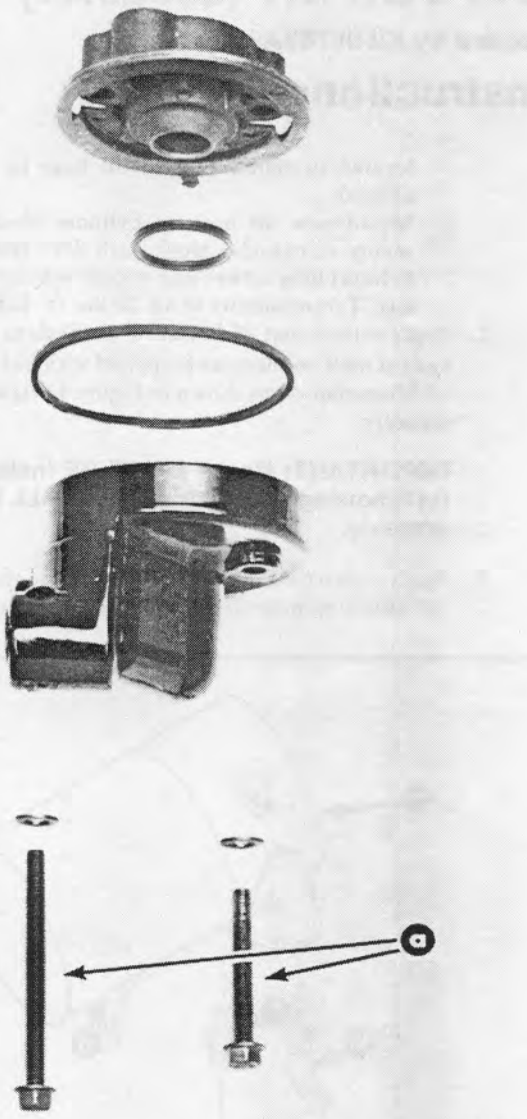
OIL FILTER BY-PASS VALVE and ADAPTOR ASSEMBLY

Figure 1. Oil Filter By-Pass Valve and Adaptor Assembly for Engines With Block Mounted Oil Filter



a - One 1/2"-13 Adaptor Attaching Bolt

Figure 2. Engines With Remote Oil Filter Adaptor (1/2"-13) Bolt



14529

a - Two 5/16"-18 Adaptor Attaching Bolts

Figure 3. Engines With Remote Oil Filter Adaptor (5/16"-18) Bolt

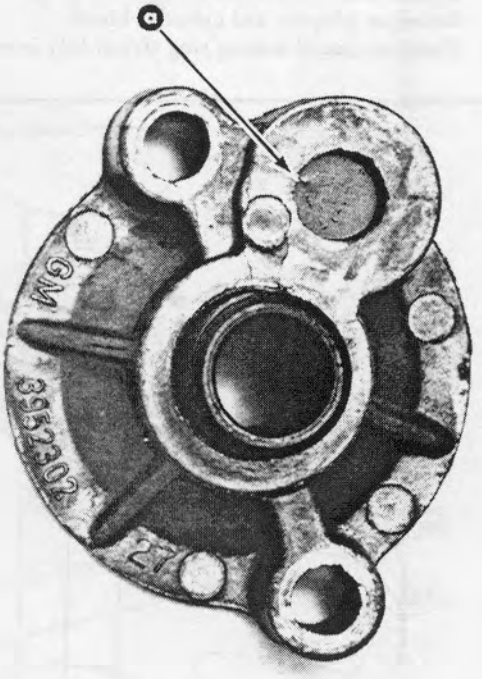
INSPECTION and/or REPLACEMENT

IMPORTANT: Hi-performance 454 CID engines do not use an oil filter by-pass valve. On these engines, by-pass valve is removed from adaptor and oil by-pass hole is welded shut. DO NOT install an adaptor with a by-pass valve incorporated as inadequate oil filteration will result.

Oil by-pass valve and adaptor assembly should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filteration is suspected.

Refer to "Engine Parts List" when ordering parts for oil filter by-pass valve, adaptor assembly or remote oil filter parts.

1. Remove oil filter (on engines with block mounted filter) or cylinder block adaptor (on engines with remote oil filter) and remove by-pass valve and adaptor assembly.
2. Clean by-pass valve and adaptor assembly in solvent and blow dry with compressed air.
3. Inspect fiber valve (Figure 4) for cracks or other damage. Check that valve fits tightly against its seat. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve and adaptor assembly should be replaced.



14530

a - Fiber Valve (Be Sure Valve Fits Tightly Against Its Seat)

Figure 4. Typical By-Pass Valve and Adaptor Assembly

4. Wipe out valve chamber in cylinder block to remove any foreign material.
5. Install by-pass valve and adaptor assembly and oil filter or cylinder block adaptor and secure as shown in Figure 1, 2 or 3. Be sure to torque bolts or screws to specifications.

REMOTE OIL FILTER ADAPTOR KIT (86029A1)

This kit has been superceded by Kit 90783A9

Installation Instructions

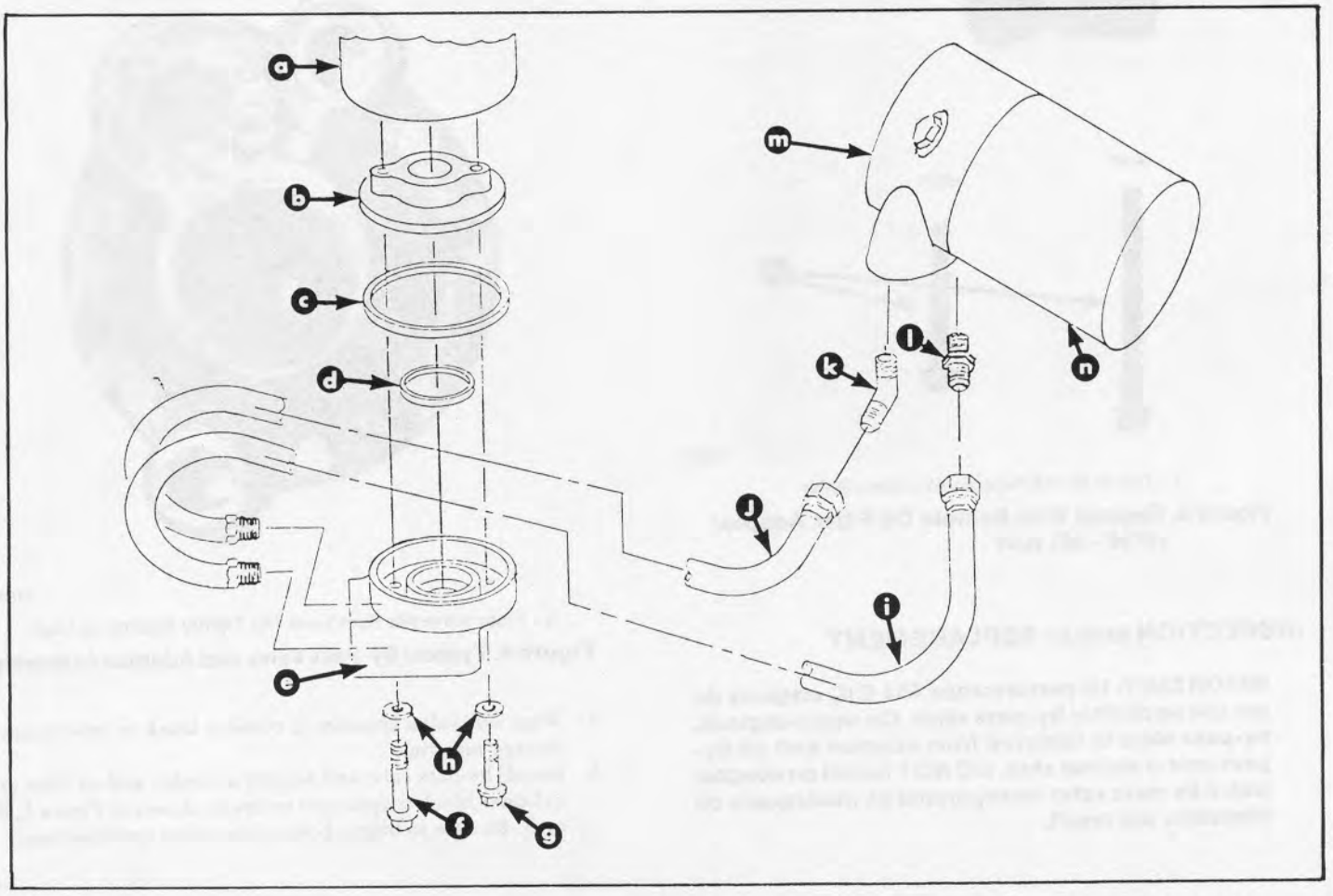
IMPORTANT: Newer style cylinder blocks are machined to accept oil filter adaptor (86029) which is secured to the block with two 5/16-18 screws. If cylinder block being replaced used the old style adaptor, that is secured to the block with one ½-13 screw, Remote Oil Filter Service Kit (86029A1) is required. Proceed with installation as follows:

ON MIE 288 and 255 INBOARD ENGINES

1. Install original by-pass valve and adaptor assembly and new oil hose to cylinder block adaptor (from kit) as follows: (Figure 1)
   a. Install original by-pass valve and adaptor on cylinder block. Position large sealing ring (from kit) in recess between adaptor and cylinder block.
   b. Position small sealing ring (from kit) in recess that is located in center of new oil hose to cylinder block adaptor.
   c. Install new oil hose to cylinder block adaptor and secure to cylinder block with 3½" (89mm) and 2½" (64mm) long screws and copper sealing washers (from kit). Torque screws to 18-20 lbs. ft. (24-27 N.m).
2. Apply a thin coat of Loctite Pipe Sealant to pipe thread ends of male connectors (supplied with kit) and install into oil filter adaptor, as shown in Figure 1. Tighten connectors securely.

   IMPORTANT: Hoses MUST BE installed properly (in following steps), or oil filter WILL NOT function properly.

3. Apply a thin coat of pipe sealant to pipe threads on end of 24" (610mm) hose (from kit), then install into hole closest



a - Engine Block
b - By-Pass Valve and Adaptor Assembly (Original)
c - Large Seal Ring (from Kit) (25-33756)
d - Small Seal Ring (from Kit) (26-73522)
e - Oil Hose to Cylinder Block Adaptor (from Kit) (86029)
f - Screw [5/16"-18 x 3-1/2" (89mm); from Kit] (10-86403)
g - Screw [5/16"-18 x 2-1/2" (64mm); from Kit] (10-86402)
h - Copper Sealing Washers (from Kit) (12-86401)
i - Hose [29-1/2" (749ml); from Kit] (32-86218)
j - Hose [24" (610mm); from Kit] (32-86217)
k - Male Connector (45°; from Kit) (22-71923)
l - Male Connector (Straight; from Kit) (22-71924)
m - Oil Filter Adaptor (Original)
n - Oil Filter

Figure 1. Remote Oil Filter System

to cylinder block on the oil hose to cylinder block adaptor. Connect other end of hose (WITHOUT applying any type of sealant to threads) to 45° male connector (installed in Step 2), as shown in Figure 1. Be sure to tighten fittings securely.

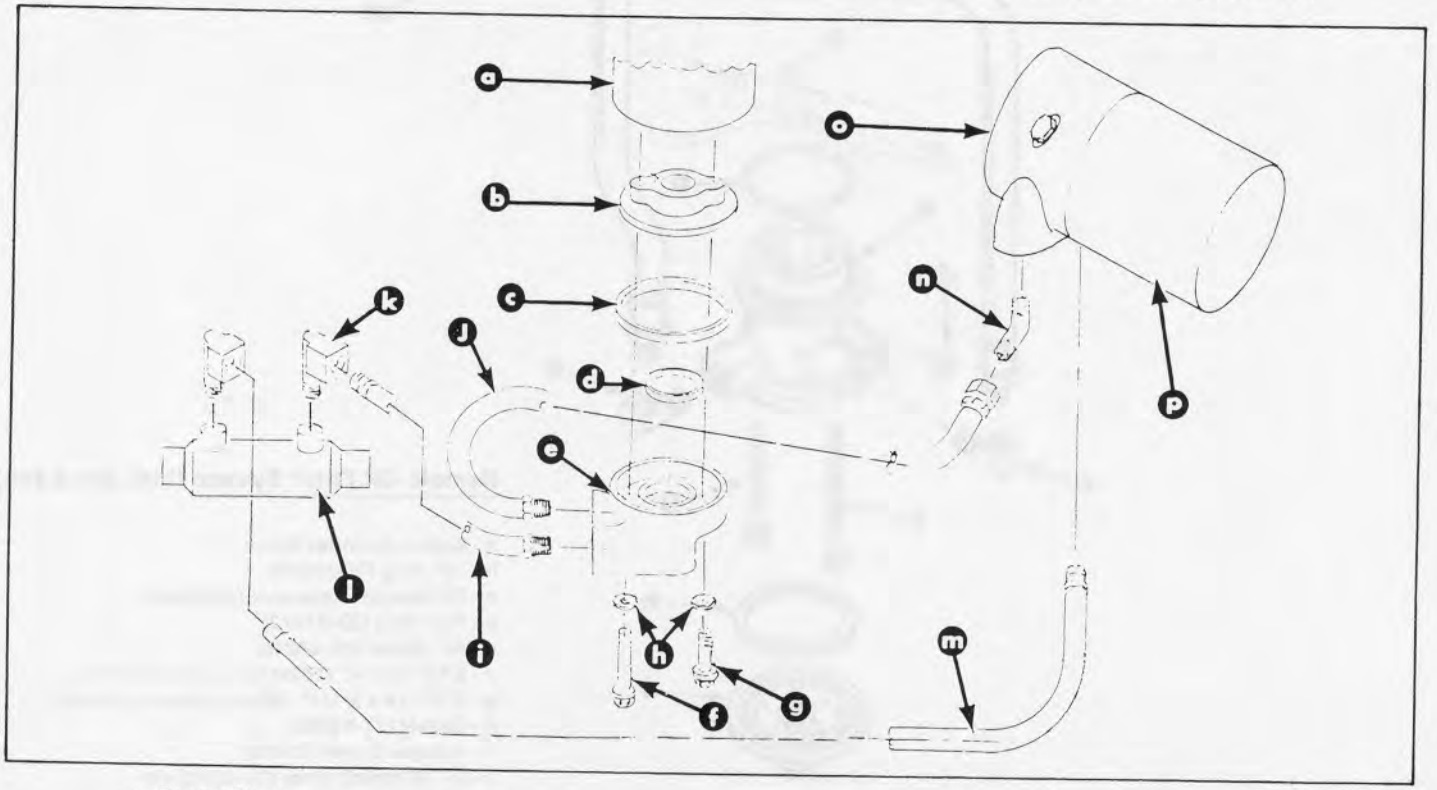
4. Apply a thin coat of pipe sealant to pipe threads on end of 29½" (749mm) hose (from kit), then install into other hole on the oil hose to cylinder block adaptor. Connect other end of hose (WITHOUT applying any type of sealant to threads) to straight connector (installed in Step 2), as shown in Figure 1. Be sure to tighten fittings securely.

ON MIE 330 INBOARD, MCM 370 STERN DRIVE ENGINES

1. Install original by-pass valve and adaptor assembly and new oil hose to cylinder block adaptor (from kit), as follows: (Figure 2)
   a. Install original by-pass valve and adaptor on cylinder block. Position large sealing ring (from kit) in recess between adaptor and cylinder block.
   b. Position small sealing ring (from kit) in recess located in center of new oil hose to cylinder block adaptor.
   c. Install new oil hose to cylinder block adaptor and secure to cylinder block with 3½" (89mm) and 2½" (64mm) long screws and copper sealing washers (from kit). Torque screws to 18-20 lbs. ft. (24-27 N.m).
2. Apply a thin coat of Loctite Pipe Sealant to pipe thread end of 45° male connector (supplied with kit) and install into oil filter adaptor, as shown in Figure 2. Tighten connector securely.

IMPORTANT: Hoses MUST BE installed properly (in following Steps), or oil filter WILL NOT function properly.

3. Apply a thin coat of pipe sealant to pipe threads on end of 24" (610mm) hose (from kit). Install hose into hole closest to cylinder block on the oil hose to cylinder block adaptor. Connect other end of hose (WITHOUT applying any type of sealant to threads) to 45° male connector (installed in Step 2), as shown in Figure 2. Be sure to tighten fittings securely.
4. Remove (and retain) hose from between oil cooler and old oil hose to cylinder block adaptor. Remove (and discard) 90° street elbow from oil cooler and replace it with new 90° elbow (from kit).
5. Apply a thin coat of pipe sealant to pipe threads on end of hose that was retained in Step 4. Install end of hose (with pipe threads) into new oil hose to cylinder block adaptor. Install other end of hose (WITHOUT applying any type of sealant to threads) into new 90° elbow (installed in Step 4), as shown in Figure 2. Be sure to tighten fitting securely.
6. Apply a thin coat of pipe sealant to pipe threads on end of original 30" (762mm) hose. Install hose into oil filter adaptor. Install other end (WITHOUT applying any type of sealant to threads) into 90° elbow on oil cooler, as shown in Figure 2. Be sure to tigthen fittings securely.



a - Engine Block
b - By-Pass Valve and Adaptor Assembly (Original)
c - Large Seal Ring (from Kit) (25-33756)
d - Small Seal Ring (from Kit) (26-73522)
e - Oil Hose to Cylinder Block Adaptor (from Kit) (86029)
f - Screw [5/16"-18 x 3-1/2" (89mm); from Kit] (10-86403)
g - Screw [5/16"-18 x 2-1/2" (64mm); from Kit] (10-86402)
h - Copper Sealing Washers (from Kit) (12-86401)
i - Hose (Original)
j - Hose [24" (610mm); from Kit] (32-86217)
k - 90° Elbow (from Kit) (22-63825)
l - Engine Oil Cooler
m - Hose [Original 30" (762mm)]
n - Male Connector (45°; from Kit) (22-71923)
o - Oil Filter Adaptor (Original)
p - Oil Filter

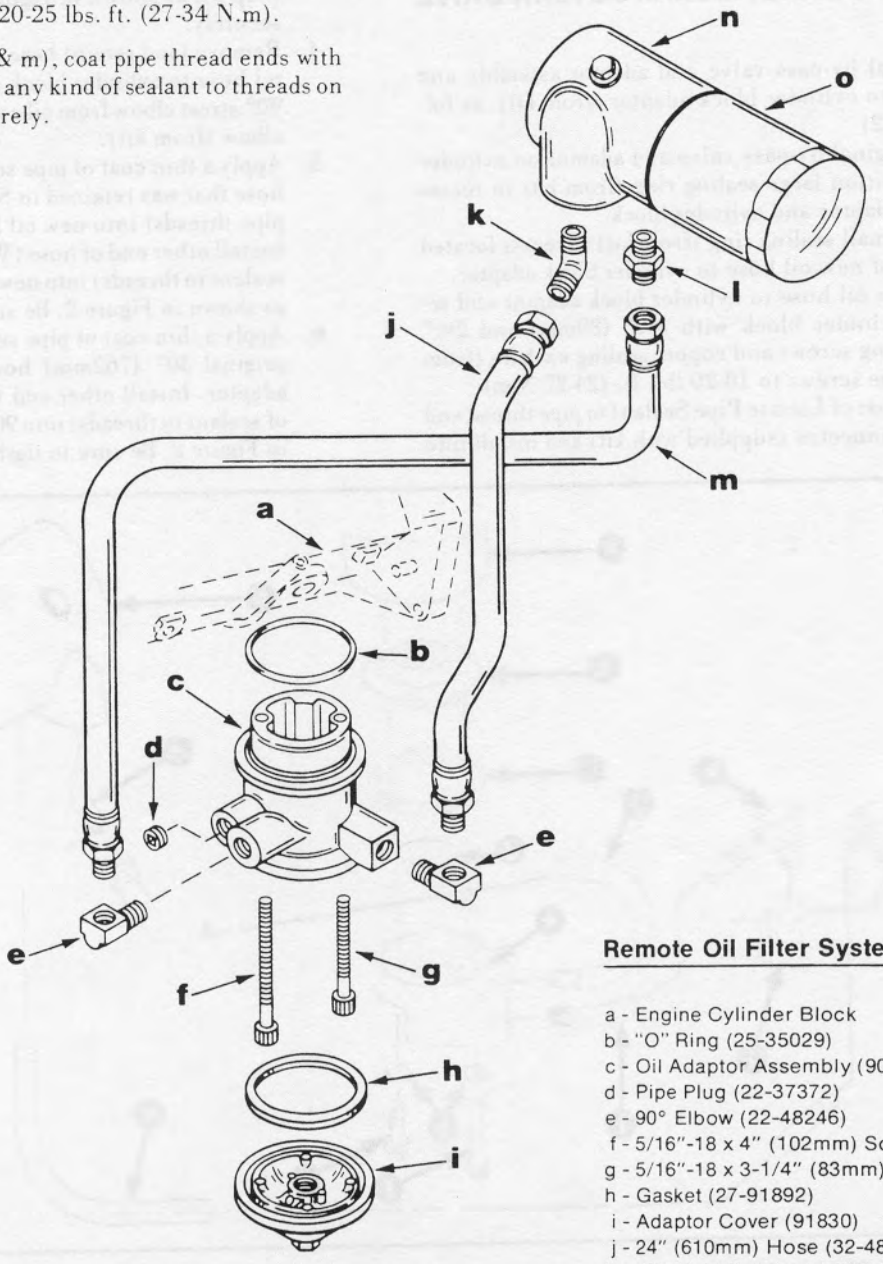
Figure 2. Remote Oil Filter System

REMOTE OIL FILTER ADAPTOR KIT 90783A9
Installation Instructions

MERCRUISER MIE 228 & 255 INBOARD ENGINES

INSTALL KIT AS SHOWN:

- Before installing pipe plug (d), 90° elbows (e), 45° male connector (k) and straight male connector (l), coat pipe threads with Quicksilver Perfect Seal. Tighten securely.
- Torque screws (f & g) to 20-25 lbs. ft. (27-34 N.m).
- When installing hoses (j & m), coat pipe thread ends with Perfect Seal. Do not apply any kind of sealant to threads on swivel ends. Tighten securely.



Remote Oil Filter System (MIE 228 & 255)

a - Engine Cylinder Block
b - "O" Ring (25-35029)
c - Oil Adaptor Assembly (90783A8)
d - Pipe Plug (22-37372)
e - 90° Elbow (22-48246)
f - 5/16"-18 x 4" (102mm) Screw (10-91966)
g - 5/16"-18 x 3-1/4" (83mm) Screw (10-91967)
h - Gasket (27-91892)
i - Adaptor Cover (91830)
j - 24" (610mm) Hose (32-48242-49)
k - 45° Male Connector (22-71923)
l - Male Connector (22-71924)
m - 30" (762mm) Hose (32-48242-55)
n - Oil Filter Adaptor (Original)
o - Oil Filter (Original)

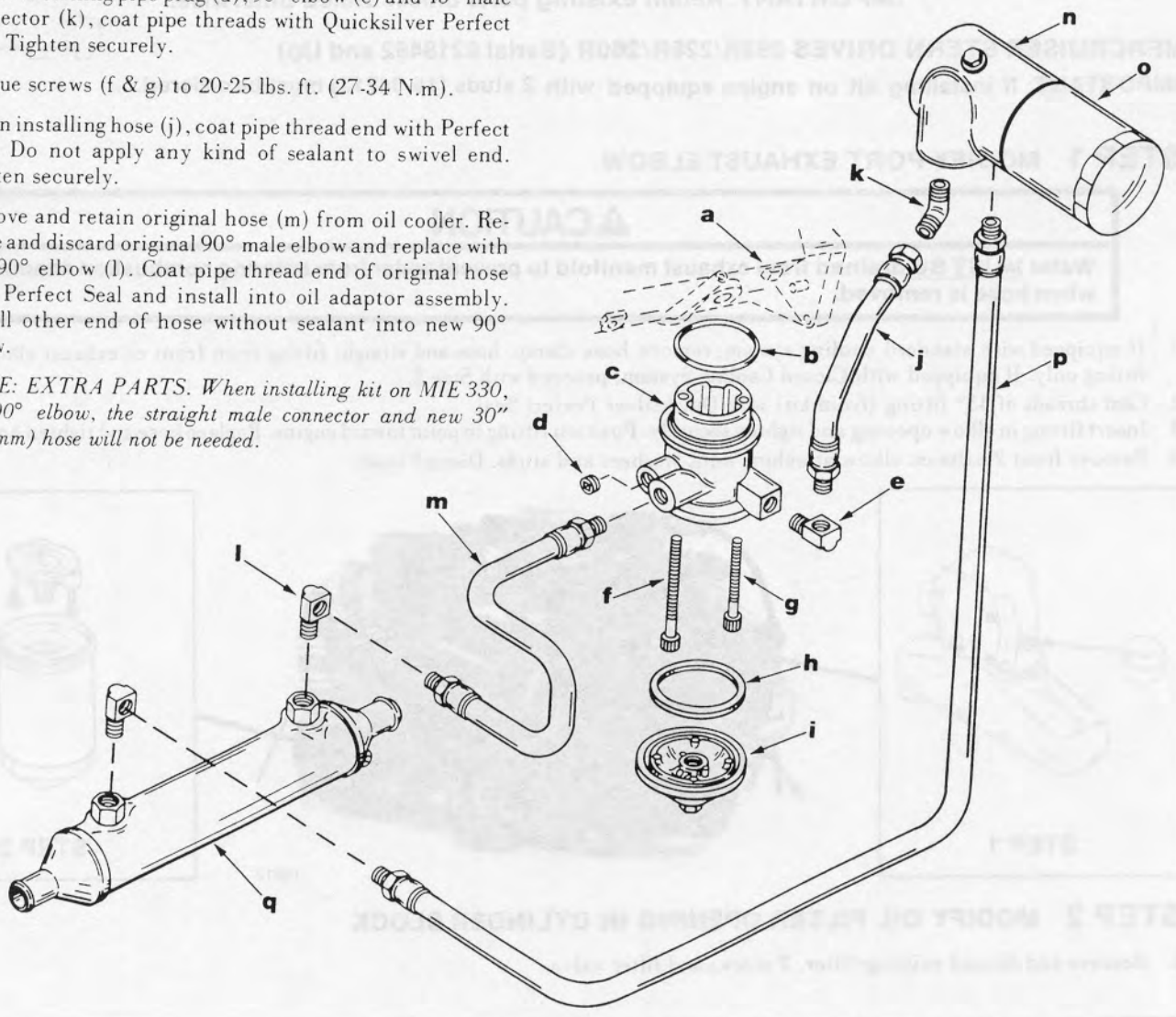
NOTE: Items b thru m are included in the kit.

389-H-1

INSTALL KIT AS SHOWN:

- Before installing pipe plug (d), 90° elbow (e) and 45° male connector (k), coat pipe threads with Quicksilver Perfect Seal. Tighten securely.
- Torque screws (f & g) to 20-25 lbs. ft. (27-34 N.m).
- When installing hose (j), coat pipe thread end with Perfect Seal. Do not apply any kind of sealant to swivel end. Tighten securely.
- Remove and retain original hose (m) from oil cooler. Remove and discard original 90° male elbow and replace with new 90° elbow (l). Coat pipe thread end of original hose with Perfect Seal and install into oil adaptor assembly. Install other end of hose without sealant into new 90° elbow.

NOTE: EXTRA PARTS. When installing kit on MIE 330, one 90° elbow, the straight male connector and new 30" (762mm) hose will not be needed.

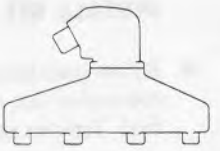


Remote Oil Filter System (MIE 330, MCM 370)

a - Engine Cylinder Block
b - "O" Ring (25-35029)
c - Oil Adaptor Assembly (90783A8)
d - Pipe Plug (22-37372)
e - 90° Elbow (22-48246)
f - 5/16"-18 x 4" (102mm) Screw (10-91966)
g - 5/16"-18 x 3-1/4" (83mm) Screw (10-91967)
h - Gasket (27-91892)
i - Adaptor Cover (91830)
j - 24" (610mm) Hose (32-48242-49)
k - 45° Male Connector (22-71923)
l - 90° Male Connector (22-63825)
m - Hose, Original (Oil Cooler to Adaptor)
n - Oil Filter Adaptor (Original)
o - Oil Filter (Original)
p - Hose, Original (Oil Cooler to Oil Filter Adaptor)
q - Engine Oil Cooler

NOTE: Items b thru m are included in the kit. 389-H-2

REMOTE OIL FILTER KIT (92043A2) INSTALLATION INSTRUCTIONS



IMPORTANT: Retain existing parts unless stated otherwise.

MERCRUISER STERN DRIVES 898R/228R/260R (Serial 6218462 and Up)

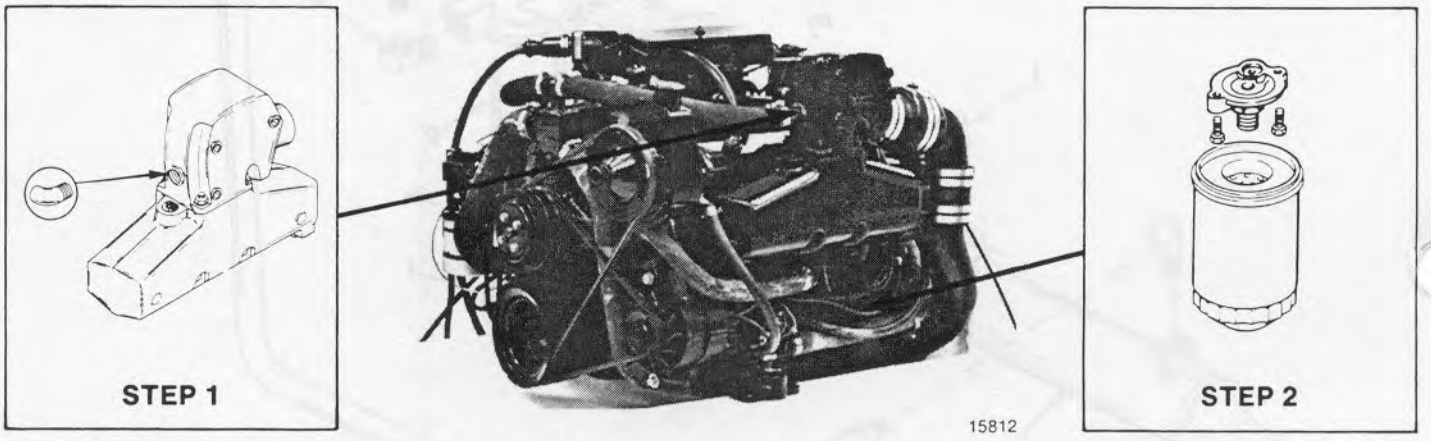
IMPORTANT: If installing kit on engine equipped with 2 studs (16-34713) must be ordered.

STEP 1 MODIFY PORT EXHAUST ELBOW

⚠CAUTION

Water MUST BE drained from exhaust manifold to prevent water from entering combustion chamber when hose is removed.

1. If equipped with standard cooling system, remove hose clamp, hose and straight fitting from front of exhaust elbow. Discard fitting only. If equipped with Closed Cooling System, proceed with Step 2.
2. Coat threads of 45° fitting (from kit) with Quicksilver Perfect Seal.
3. Insert fitting in elbow opening and tighten securely. Position fitting to point toward engine. Replace hose and tighten hose clamp.
4. Remove front 2 exhaust elbow attaching nuts, washers and studs. Discard studs.



STEP 2 MODIFY OIL FILTER OPENING IN CYLINDER BLOCK

1. Remove and discard existing filter, 2 screws and filter valve.

STEP 3 INSTALL REMOTE OIL FILTER ASSEMBLY

1. Remove oil filter adaptor cover and mount adaptor body with 2 screws provided. Be sure cover seal and adaptor "O" ring are in place. Torque to 20-25 lbs. ft. (27-34 N.m).
2. Route hoses up and between exhaust manifold and engine.

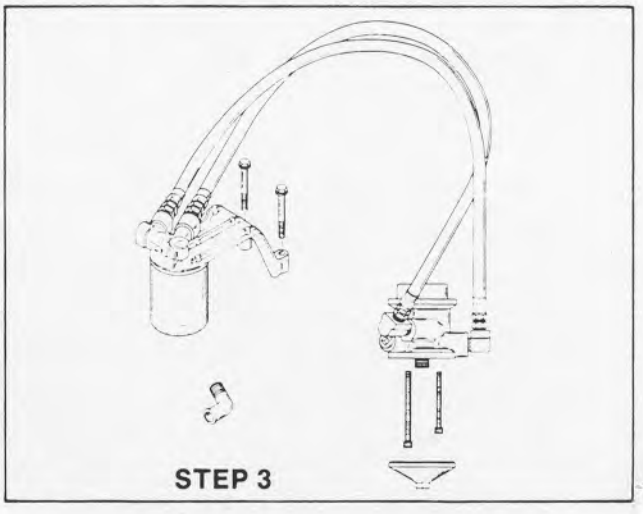
⚠CAUTION

Hoses must not contact hot spots on exhaust manifold.

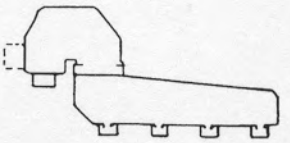
3. Install oil filter bracket on front of exhaust elbow. Where elbow is fastened to manifold or 6" (152mm) riser, use 2 screws (from kit) and original washers. Discard original nuts. Torque to 20-25 lbs. ft. (27-34 N.m).

   NOTE: If installing kit on engine equipped with 3" (76mm) risers and replacement studs, use original washers and nuts. Discard 2 screws from kit.

4. Run engine until warm. Stop engine and wait 5 minutes. Check crankcase oil level and add oil if necessary.



MERCRUISER GM V-8 305/350 CID STERN DRIVES (Serial 6218461 and Below)

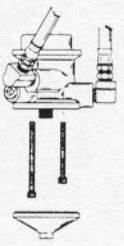


NOTE: The remote oil filter bracket is installed on a convenient hull stringer.

STEP 1 INSTALL OIL FILTER ADAPTOR IN CYLINDER BLOCK

1. Remove and discard existing filter, 2 screws and filter valve.

2. Remove oil filter adaptor cover and mount adaptor body with 2 screws provided. Be sure cover seal and adaptor "O" ring are in place. Torque to 20-25 lbs. ft. (27-34 N.m).

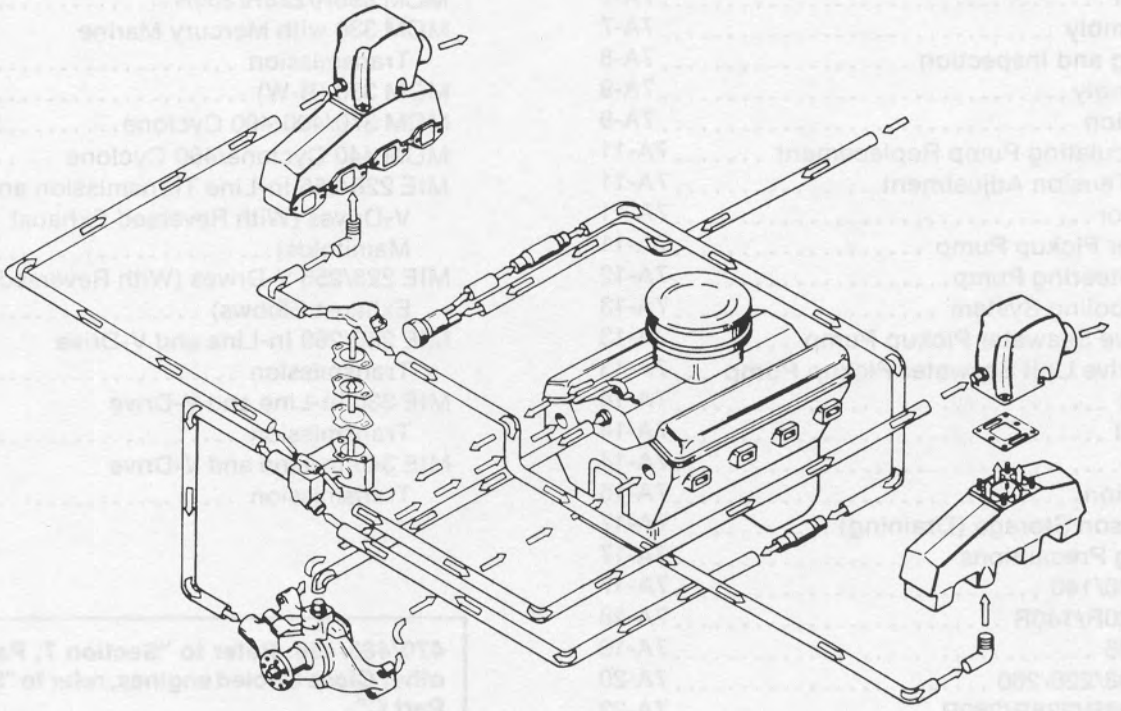


STEP 2 INSTALL OIL FILTER BRACKET ON HULL STRINGER

1. Route hoses in most convenient manner.
2. Install filter bracket on stringer with screws and washers (not provided). Discard 2 screws and elbow from kit.
3. Run engine until warm. Stop engine and wait 5 minutes. Check crankcase oil level and add oil if necessary.

SECTION 7 - COOLING SYSTEM

PART A - SEAWATER COOLED MODELS



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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470/485/488: Refer to "Section 7, Part B". All other Close Cooled engines, refer to "Section 7, Part C".

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace to Alternator		192 (28)
Alternator Brace to Block	30 (41)	
Alternator to Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
Drain Plugs (Note 1)	Securely	
Hose Clamps	Securely	
Petcocks	Securely	
Power Steering Pump Brace to Block	30 (41)	
Power Steering Pump Bracket	30 (41)	
Pulleys	Securely	
Seawater Pump Brace	30 (41)	
Seawater Pump Bracket to Block	30 (41)	
Seawater Pump Clamping Screw on Cast Bracket	20 (27)	
Seawater Pump Cover		120 (14)
Seawater Pump Mounting Nuts to Stamped Steel Bracket		120 (14)
Thermostat Cover (120/140/165)	20 (27)	
Thermostat Cover (V-8 Engines)	30 (41)	
Thermostat Housing	30 (41)	
Thru-Hull Pickup Nut	35 (42)	
Water Circulating Pump	30 (41)	
Water Temp. Sender	20 (27)	

NOTE 1. Coat threads with perfect seal before installing.

TOOLS/LUBRICANTS/SEALANTS

TOOLS/LUBRICANTS/SEALANTS	
91-37241	Universal Puller Plate
92-32609-1	Quicksilver Loctite (A)
92-34227-1	Quicksilver Perfect Seal
92-86154A1	Quicksilver 2-4-C Mult-Lube
92-79214A1	Quicksilver Special Lubricant 101
73971A2	Flush Device

LUBRICANT OBTAINED LOCALLY
Shell Alvania No. 2

SPECIFICATIONS

COOLING SYSTEM CAPACITY	
Model	**Qts (litres) Approximately**
MCM 120/140	9 (8.5)
MCM 165	11 (10.4)
MCM 898/228/260	15 (14.1)
MCM 898R/228R/260R	15 (14.1)
MCM 330	20 (18.9)
MCM 330 (B-W)	20 (18.9)
MCM 370	20 (18.9)
MIE 228/255	15 (14.1)
MIE 230/260	15 (14.1)
MIE 330	20 (18.9)
MIE 340	20 (18.9)

THERMOSTAT	
All Models	143° F (62° C)

SEAWATER INLET RECOMMENDATIONS

TRANSOM MOUNTED OR THRU-HULL SEAWATER PICKUPS AND HOSE

Water pickup MUST BE large enough to permit sufficient water flow to engine seawater pickup pump for adequate engine cooling [30 gal. per min. (114 litres per min.) minimum]. Pickup also must supply a positive head while underway.

⚠CAUTION

DO NOT install water pickup directly in line with propeller, as pickup may create turbulence and allow air to flow into the "propeller slipstream". This will cause propeller ventilation and will adversely affect boat performance.

Water pickup should be located as close to seawater pickup pump inlet as possible and in an area where an uninterrrupted, solid stream of water will flow past when boat is underway. Connect water pickup to seawater pickup pump inlet with 1¼" (32mm) ID wire reinforced hose of adequate wall thickness to prevent it from collapsing from pump suction. Be sure to secure hose connections with hose clamps.

SEAWATER INLET VALVE

If a seawater inlet valve is being used, it must be installed between water pickup and seawater pickup pump (or sea strainer), to allow operator to shut off the seawater in case of a leak or when boat is not in use. This will allow the operator to flush or drain the engine, or clean the sea strainer while boat is in the water. Valve used MUST have an internal cross-sectional area equal to or greater than hose to prevent restricting water flow. Install valve in an area where it will be easily accessible and support adequately to prevent hose fatigue.

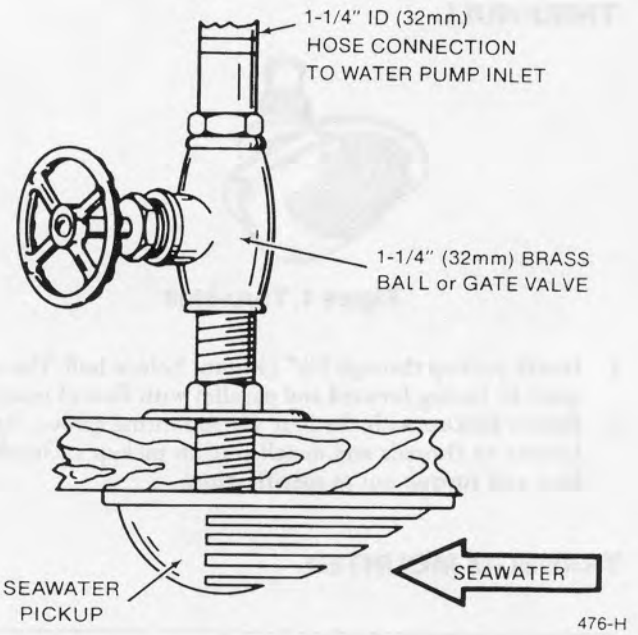


Figure 1. Seawater Inlet Valve (Thru-Hull Pickup Shown)

SEA STRAINER

If boat is equipped with a sea strainer, it MUST BE of sufficient size to ensure that an adequate supply of water is maintained for engine cooling. Install seawater strainer in an area where it will be easily accessible for inspection and cleaning. Strainer should be installed in water inlet hose after water inlet valve to allow operator to shut off water when cleaning strainer.

SEAWATER PICKUPS

THRU-HULL

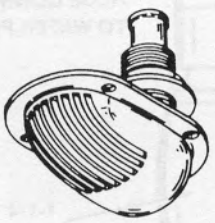
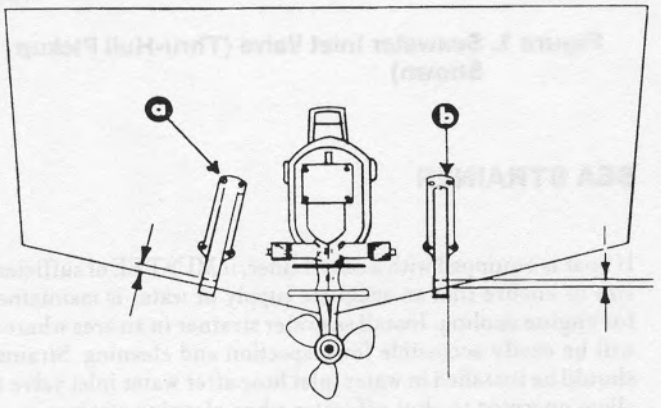


Figure 1. Thru-Hull

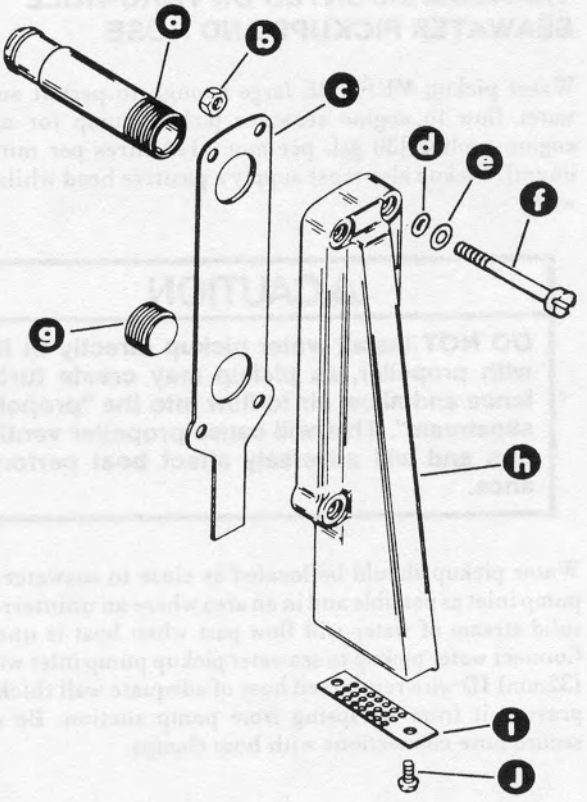
1. Install pickup through 1¾" (44mm) hole in hull. The slots must be facing forward and parallel with flow of water.
2. Fasten pickup with the four (4) mounting screws. Apply Loctite to threads and install nut on pickup on inside of boat and torque nut to specifications.

TRANSOM MOUNTED



a - Diagonal Mount [Leading Edge of Pickup 1/8" (3.2mm) from Boat Bottom]
b - Verical Mount [Corner of Leading Edge of Pickup 1/8" (3.2mm) from Boat Bottom]

Figure 2. Water Pickup Installed on Transom



a - Hose Nipple - Pipe Thread Sealer on Threads, Tighten Securely
b - Nuts (4) - Tighten Securely
c - Gasket - Between Pickup and Transom
d - "O" Ring (4)
e - Washer (4)
f - Screw (4) - Coat Each Shaft With Silicone Sealant or Equivalant
g - Plastic Plug - Teflon Paste to Threads, Tighten Securely
h - Pickup
i - Screen
j - Screw (2) - Tighten Securely

Figure 3. Seawater Pickup Installation

SEAWATER PICKUP PUMP OUTPUT TEST

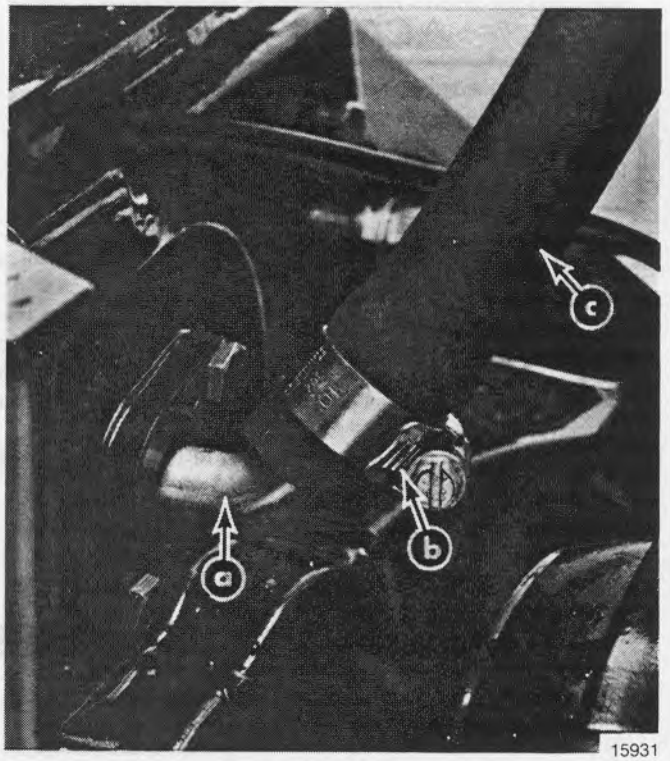
If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool engine.

IMPORTANT: The following information should be observed before proceeding with test:

- **BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT BE performed with a flush-test device and a water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy in which it is performed. An error in setting the engine RPM, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5% should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within 1 second. An 8 quart (7.6 litre) or larger capacity container calibrated in ¼ quart increments should be used to measure water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.**

1. **Stern Drive Seawater Pickup Pump Models:** Remove water inlet hose, which runs between gimbal housing water tube and engine (Figure 1), and replace with another hose of same diameter, but approximately 3 ft. (1m) longer. Hose should be wire reinforced or of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at gimbal housing water tube only. Do not clamp hose at engine end.

   Belt Driven Seawater Pickup Pump: Remove water hose, which runs between pump outlet and engine (Figure 2), and replace with another hose of same diameter, but approximately 3 ft. (1m) longer. Hose should be wire reinforced or of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at pump outlet only. Do not clamp hose at engine end.



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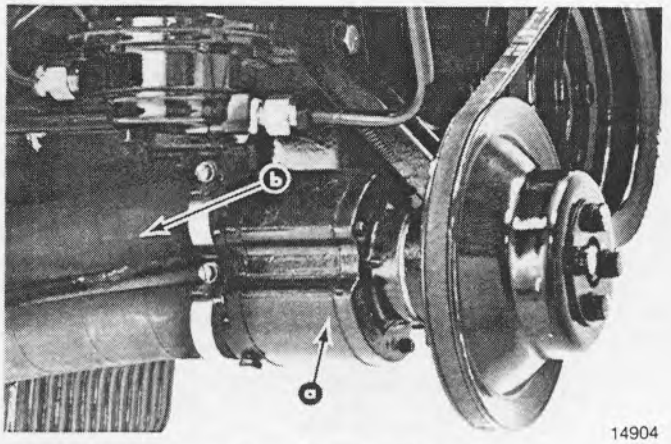
a - Water Tube
b - Hose Clamp
c - Water Hose

Figure 1. Stern Drive Pump Models



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a - Seawater Pickup Pump
b - Seawater Outlet Hose

Figure 2. Belt Driven Pump Models

2. Place an 8 quart (7.6 litres) or larger container near unclamped end of hose.

⚠CAUTION

Do not run engine for more than 15 seconds with hose disconnected, in next step, as internal damage to engine and exhaust system may result.

3. With assistance of another person, start engine and adjust speed to exactly 1000 RPM, while holding unclamped end of hose on connection on engine. Remove hose from connection on engine and direct water flow into container for EXACTLY 15 seconds. At the end of 15 seconds, direct the water flow overboard, return engine to idle and stop engine. Reconnect hose to engine.
4. Measure quantity of water discharged into container and compare with specifications given in chart below.
5. Repeat test 4 times to check repeatability of results.

STERN DRIVE PUMP OUTPUT FOR 15 SECOND PERIOD	
Drive Unit Gear Ratio	**Minimum Quantity**
1.98:1	3.0 Qts. (2.8 litres)
1.84:1	3.3 Qts. (3.1 litres)
1.65:1	3.6 Qts. (3.4 litres)
1.50:1	4.0 Qts. (3.8 litres)
1.32:1	4.5 Qts. (4.3 litres)

BELT DRIVEN PUMP OUTPUT FOR 15 SECOND PERIOD
7.5 Qts. (7.1 litres) Minimum

STERN DRIVE UNIT SEAWATER PICKUP PUMP

NOTICE

MCM 120 - 260 have a seawater pickup pump mounted in stern drive unit. Refer to "Stern Drive Service Manual" for repairs.

BELT DRIVEN SEAWATER PICKUP PUMP

REMOVAL

⚠CAUTION

If boat is in the water, be sure to close water inlet valve before removing inlet hose from pump to prevent water from draining into boat. If boat is not fitted with a valve either plug inlet or raise it above water level after removing.

IMPORTANT: The following procedure describes removal of both pump and mounting bracket from engine. On some installations, however, it may be possible to remove pump with mounting bracket left installed on engine.

1. Disconnect water inlet and outlet hoses from pump.
2. If pump is to be disassembled, break loose 4 pump pulley attaching screws. Do not remove screws at this time.
3. **On Engines With Power Steering:** Remove Power Steering pump drive belt to allow removal of seawater pickup pump drive belt. (Some models)
4. Remove pulley attaching screws and clamping ring (some models) then remove pulley.
5. Remove attaching hardware which secure pump brace to cylinder block, oil pan or Power Steering pump (as applicable).
6. Remove pump mounting bracket-to-cylinder block attaching hardware and remove pump, mounting bracket and brace as an assembly.
7. **Models With Cast Bracket (Figure 6):** Loosen clamping screw, then remove pump. It may be necessary to spread clamping bosses.
8. **Models With Stamped Steel Bracket (Figure 7):** Remove 3 mounting nuts, then remove pump.

DISASSEMBLY

1. Remove cover and body attaching screws and washers. Remove cover, gasket, outer wear plate and gasket. (Discard gaskets.)
2. Slide pump body off shaft. Remove impeller from pump body and rubber plug from impeller.

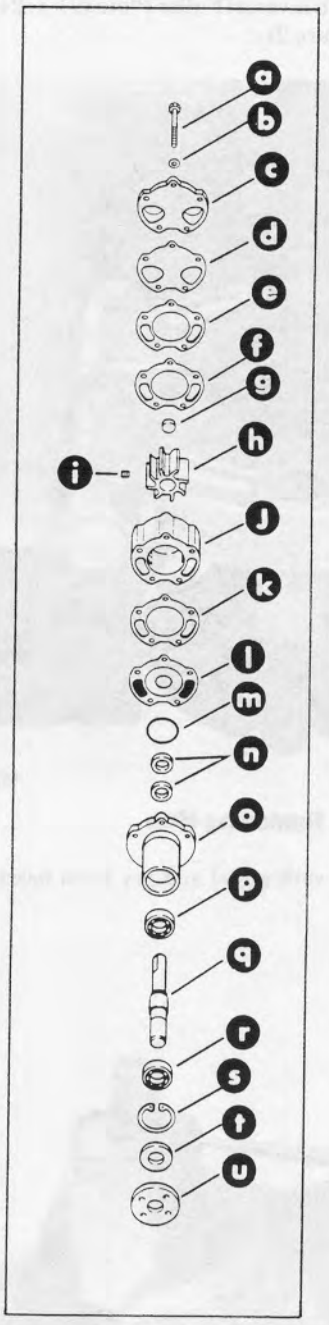

Figure 1. Pump Assembly

3. Remove impeller drive key from pump shaft, then remove gasket, inner wear plate and "O"ring (or Quad Ring). Discard gasket and "O" ring (or Quad Ring).
4. Press hub off shaft with Universal Puller Plate (91-37241) and an arbor press. (Figure 2)

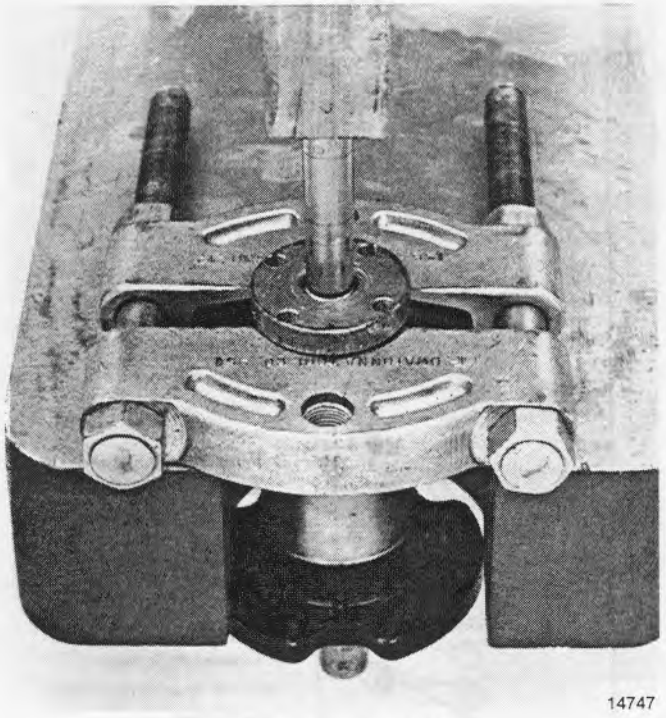
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Figure 2. Removing Hub

5. Puncture front oil seal with a tool and pry from bearing housing. (Figure 3)

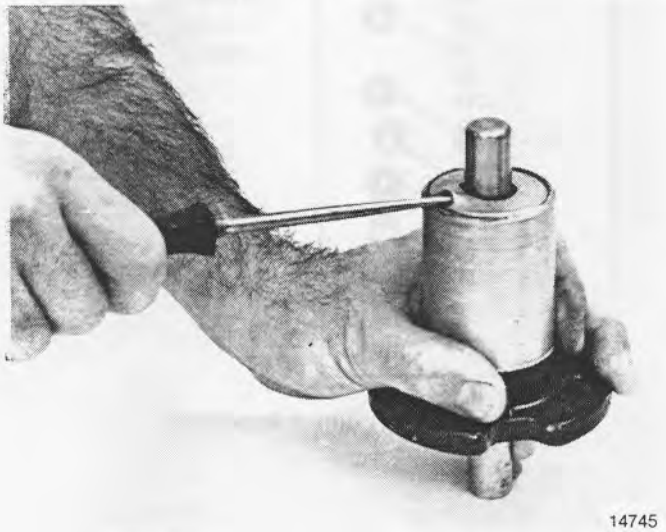
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Figure 3. Removing Front Oil Seal

6. Remove snap ring from bearing housing bore and press shaft and bearings out pulley end of housing. Bearings have a slip fit in housing, do not use excessive force.
7. If bearings require replacement, remove bearings from shaft with Universal Puller Plate and an arbor press. (Figure 4) Bearings MUST BE replaced, if removed.

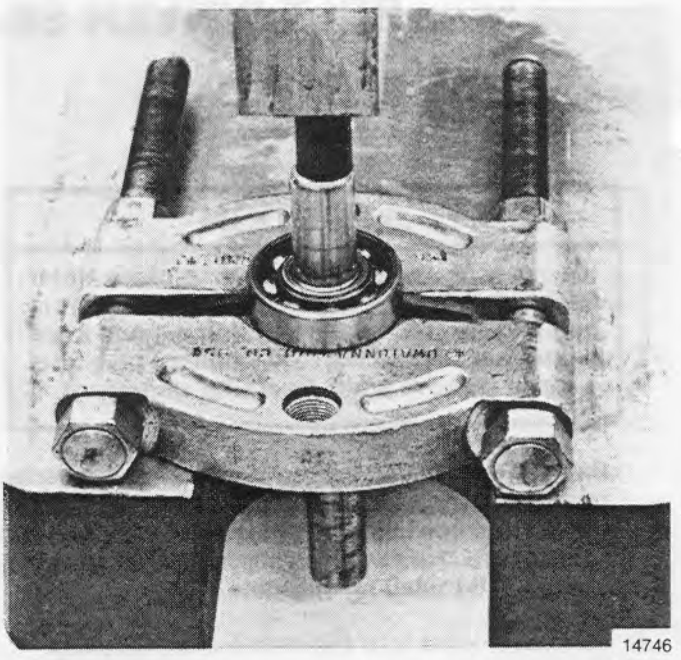
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Figure 4. Removing Bearings from Pump Shaft

8. If rear seals require replacement, press seals from bearing housing with an appropriate tool.

CLEANING and INSPECTION

1. Clean metal parts in solvent and blow dry with compressed air.

   IMPORTANT: DO NOT spin bearings at high speed when drying with compressed air, as bearings may be scored.

2. After cleaning, apply a coat of light engine oil to shaft and bearings to prevent rust.
3. Clean all gasket material and sealer from sealing surfaces.
4. Inspect bearing housing. Examine surfaces (where bearings contact housing) for evidence of bearing outer races turning in housing.
5. Inspect seals in bearing housing.
6. Inspect pump shaft bearings.
7. Inspect pump shaft for grooves in surface where seals contact shaft. Inspect keyway in shaft. Also, inspect surface, where bearings contact shaft, for evidence of inner races turning on shaft.
8. Inspect impeller drive key.
9. Inspect pump body.
10. Inspect inner and outer wear plate.
11. Inspect pump impeller for wear on sides and tips of blades. Also inspect blades for cracks in area where blades flex. Replace impeller, if blades have taken a set (remain in curved position).
12. Inspect pump pulley.
13. Check drive belt for excessive wear.

REASSEMBLY

Refer to Figure 1 also.

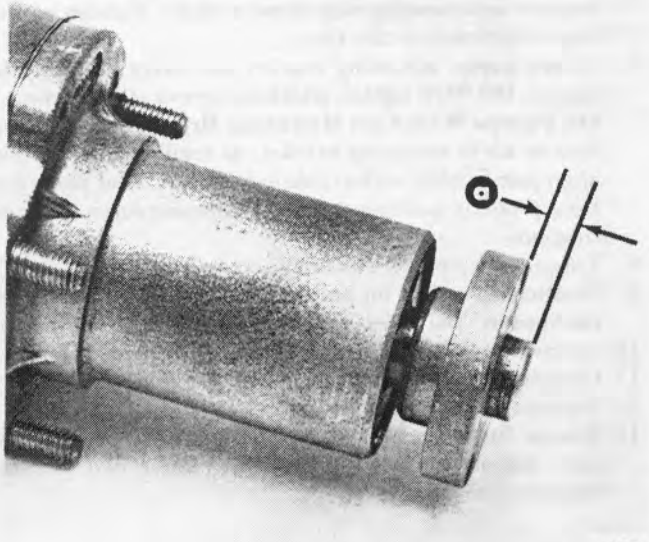
1. Apply a thin coat of Loctite Type "A" to outside diameter of 2 new bearing housing rear seals, then install seals in housing with seal lips facing impeller end. (Press first seal in until it bottoms-out and second seal in until flush with housing.)

   IMPORTANT: It is recommeded that Shell Alvanina No. 2 Grease be used when packing seal and bearings in the following steps. If Shell Alvania No. 2 Grease is not available, it is permissable to use 2-4-C. However, 2-4-C Multi-Lube is not recommended for applications where continuous high speed heavy-duty operation will be encountered.

2. Pack cavity between seals with Shell Alvania No.2 Grease or substitute.
3. Using an arbor press and suitable tool, press ball bearings onto shaft until they seat. Press on inner race of bearing only.
4. Pack bearings and cavity between bearings with Shell Alvania No. 2 Grease or substitute. Slide bearings and shaft into bearing housing bore and install snap ring.
5. Apply a thin coat of Loctite "A" to outside diameter of new bearing housing front oil seal and press seal into housing (with seal lip facing inward) until it bottoms out.

   IMPORTANT: Be sure to support impeller end of pump shaft, when installing pulley hub, in next step, to prevent placing a load on bearings.

6. Apply Special Lubricant 101 to pump shaft. Using an arbor press and appropriate tool, press pulley hub onto pump shaft to dimension shown in Figure 5.



a - .260" (6.6mm)

Figure 5. Pulley Hub Dimension

IMPORTANT: Pulley hub MUST BE pressed onto shaft to exact dimension on pumps with stamped steel mounting bracket as this establishes proper drive belt alignment.

7. Clamp beauring housing in a soft jawed vise with flange end up.
8. Coat "O" ring (or Quad ring) with 2-4-C Multi-Lube and install into groove in housing.
9. Place inner wear plate on housing and align holes. Coat both sides of a new wear plate gasket with a thin film of Perfect Seal and position on wear plate.
10. Install impeller into pump body by turning impeller in direction that it will be turning in operation, while simultaneously pushing inward. All impeller blades MUST face in same direction.
11. Apply a small amount of grease to back side of impeller drive key (to hold it in place) and position key in keyway on shaft. Align groove in impeller hub with drive key and slide impeller and pump body assembly onto shaft. Position pump body so that holes align with holes in wear plate, gasket and bearing housing. Install rubber plug into end of impeller.
12. Coat both sides of new cover gasket and wear plate gasket with a thin film of Perfect Seal. Install outer wear plate with new gaskets on each side, aligning holes in plate and gaskets with holes in pump body.
13. Install pump cover and secure with 5 screws and washers. Torque screws to specifications.

INSTALLATION

1. Position pump in mounting bracket so that outlet connection will be directly ABOVE inlet connection when pump is installed. (Refer to Figures 6, 7, 8 and 9)

   IMPORTANT: Pump must be positioned correctly or overheating of engine may occur.

Figure 6. Cast Bracket

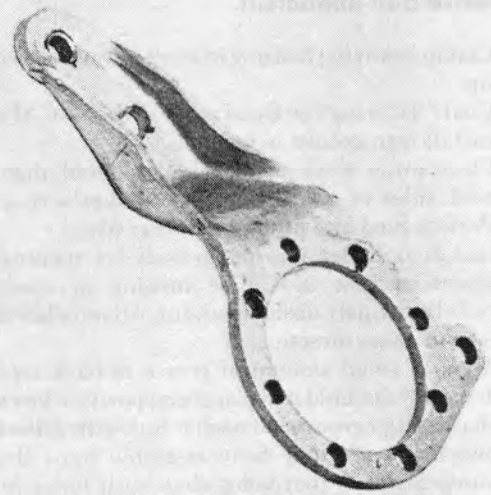


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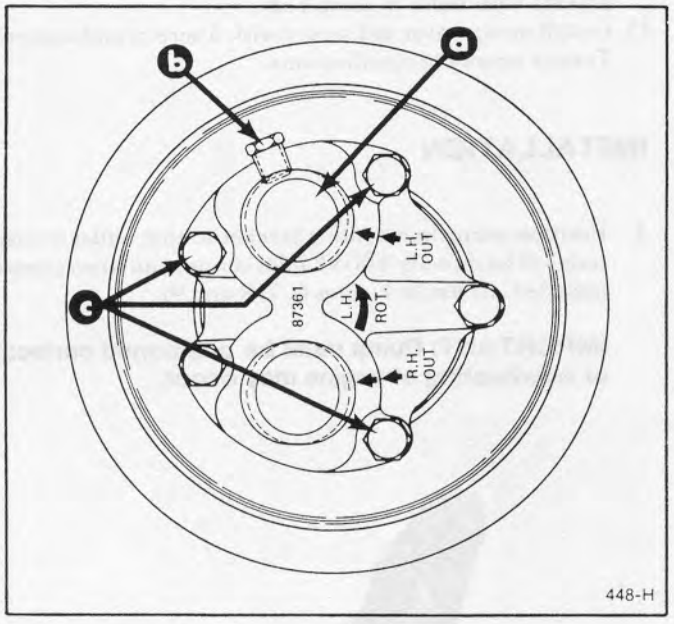
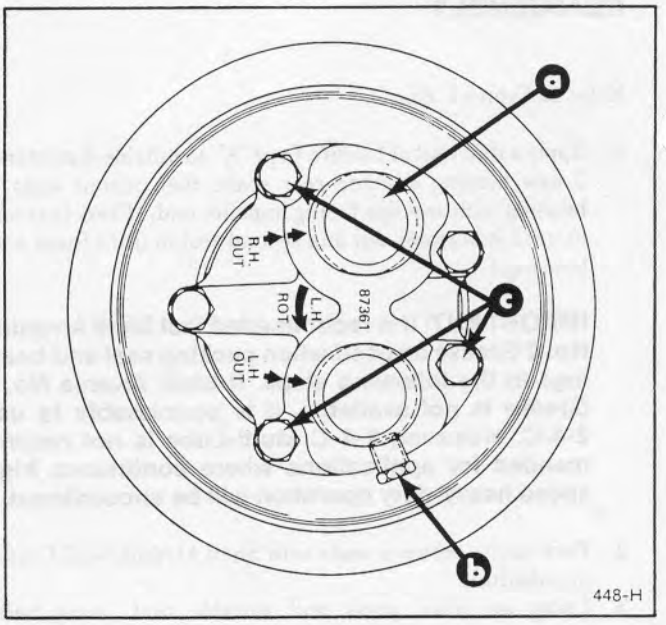
Figure 7. Stamped Steel Bracket



a - L.H. Out - At Top
b - Brass Plug - At Top
c - Stamped Steel Bracket Mounting Screws - 3-3/4" (95mm) Long

Figure 8. MCM and MIE L.H. (Standard) Rotation Engines

2. **On Pumps with Stamped Steel Mounting Bracket:** Secure pump to mounting bracket with 3 lockwashers and nuts. Torque nuts to specifications.
3. **On Pumps With Cast Mounting Bracket:** Install flat-



a - R.H. Out-At Top (Some Pumps are Not Marked. In Those Cases, "Out" is At Bottom)
b - Brass Plug - At Bottom
c - Stamped Steel Bracket Mounting Screws 3-3/4" (95mm) Long

Figure 9. MIE R.H. (Opposite) Rotation Engines

washer (spacer) between mounting bracket clamping bosses and install clamping screw and lockwasher. DO NOT tighten screw at this time.

IMPORTANT: Flat washer MUST BE installed between mount bracket clamping bosses or damage to pump may result (if clamping screw is overtightened).

4. Attach brace to pump mounting bracket with screw, lockwasher and nut. DO NOT tighten at this time.
5. Install pulley on pump and secure with 4 screws, lockwashers and clamping ring (some models). Tighten screws finger tight only at this time.
6. Attach pump, mounting bracket and brace assembly to engine. DO NOT tighten attaching screws at this time.
7. **On Pumps With Cast Mounting Bracket:** Slide pump fore or aft in mounting bracket, as required, to properly align pump pulley with crankshaft pulley. After pump has been properly positioned, torque clamping screw to specifications
8. Torque pump pulley attaching screws.
9. Position drive belt on pulleys and adjust belt tension as outlined in "Drive Belt Tension Adjustment" (see Index).
10. Connect seawater inlet hose to lower fitting on pump.
11. Connect outlet hose to upper fitting on pump.
12. Tighten hose clamps securely.
13. **Power Steering Models:** If applicable, reinstall drive belt. Adjust tension as outlined in "Drive Belt Tension Adjustment" (see Index).

WATER CIRCULATING PUMP REPLACEMENT

REMOVAL

1. Drain water from cylinder block.
2. Break loose circulating pump pulley attaching bolts. DO NOT remove bolts at this time.
3. **Power Steering Models:** Loosen power steering pump brace and pump mounting bolts, then pivot pump inward and remove drive belts (some models).
4. Loosen alternator brace attaching bolts and alternator mounting bolt, then pivot alternator inward and remove drive belt.
5. Remove pump pulley attaching bolts, lockwashers, clamp ing ring (if so equipped) and pulley.
6. Disconnect hose(s) from pump.
7. Remove bolts, which secure pump to cylinder block, and remove pump and old gasket(s) [Discard gasket(s).]

CLEANING and INSPECTION

1. Clean gasket surfaces on water pump and cylinder block.
2. Inspect water pump for blockage, cracks, sand holes, corrosion or other damage. Inspect pump impeller for cracks and erosion. Replace complete pump, if any damage exists.
3. Check impeller shaft and bearings for excessive side play. If play can be felt, replace complete pump.
4. Inspect pump pulley for bends, cracks, corrosion or other physical damage. Inspect pulley for rotational trueness. Replace pulley if damaged or untrue.

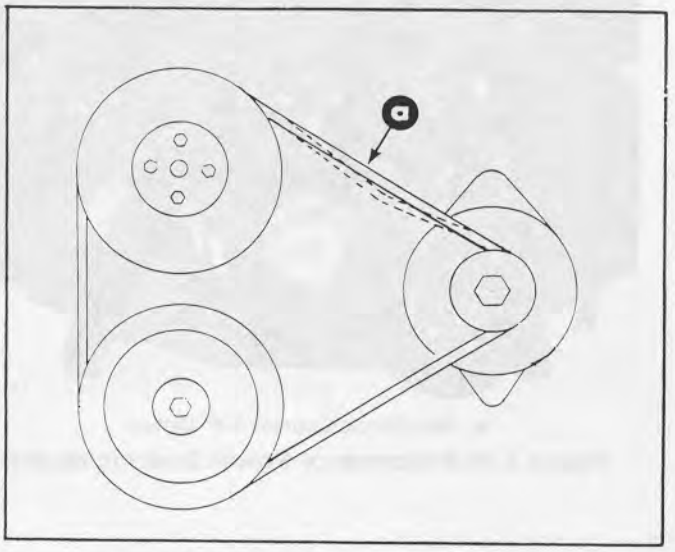
INSTALLATION

1. Coat both sides of new circulating pump gasket(s) with Perfect Seal, then position gasket(s) and circulating pump on cylinder block. Coat threads of circulating pump attaching bolts with Perfect Seal and install bolts and alternator brace (if applicable.). Torque bolts to specifications.
2. Reconnect hose(s) to pump.
3. Install pump pulley and clamping ring (if used) on pump hub and secure with bolts and lockwashers. Tighten bolts securely.
4. Install drive belt(s) and adjust tension as outlined in. "Drive Belt Tension Adjustment" (see Index).
5. If engine is equipped with Closed Cooling, fill closed cooling section with coolant in accordance with Section 7, Part C "Filling Instructions".
6. Start engine and check for leaks.

DRIVE BELT TENSION ADJUSTMENT

ALTERNATOR

1. Install drive belt on pulleys and adjust tension as follows (Figure 1):
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown in Figure 1.
   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolt.



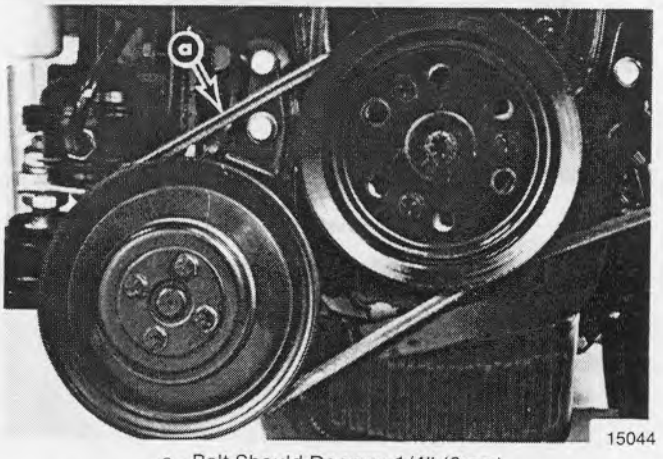
a - Belt Should Depress 1/2" (13mm)

Figure 1. Alternator Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

SEAWATER PICKUP PUMP

1. Install drive belt on pulleys and adjust tension as follows. (Figure 2)
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown in Figure 2.
   b. After obtaining correct tension, securely retighten pump brace and pump mounting bolts.



a - Belt Should Depress 1/4" (6mm)

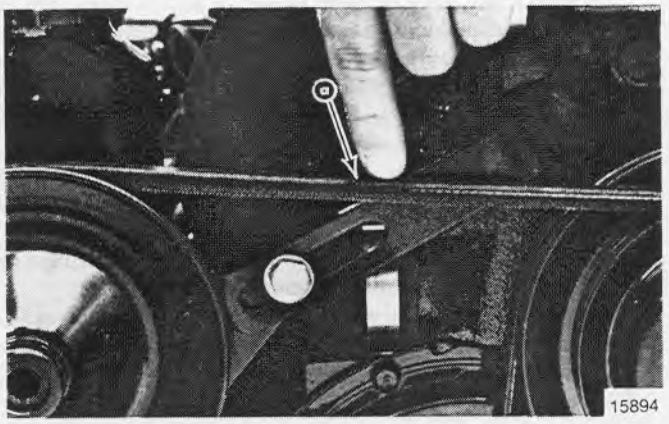
Figure 2. Seawater Pump Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

POWER STEERING PUMP

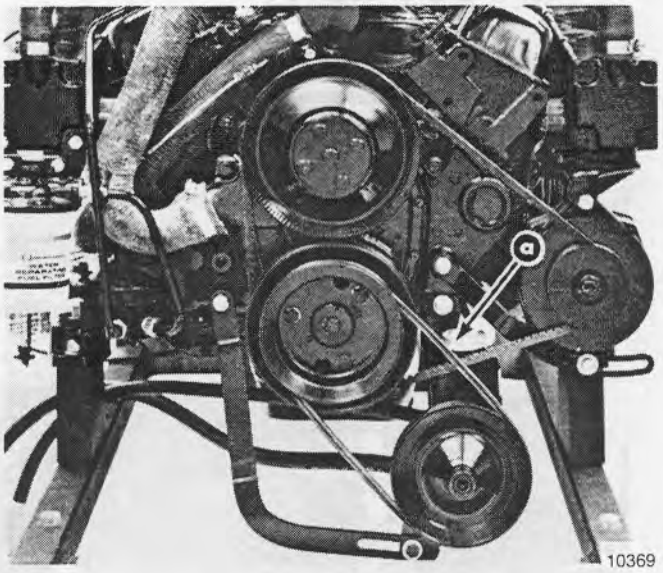
IMPORTANT: DO NOT pry on pump with pry bar or screwdriver.

1. Install drive belt on pulleys and adjust tension as follows. (Figures 3, 4, 5, 6 or 7)
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown.
   b. After obtaining correct tension, securely retighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for 5minutes.



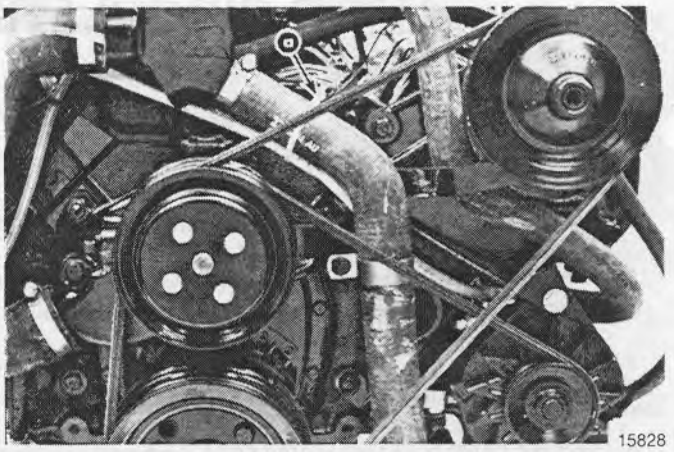
a - Belt Should Depress 1/4" (6mm)

Figure 3. MCM 120/140/165



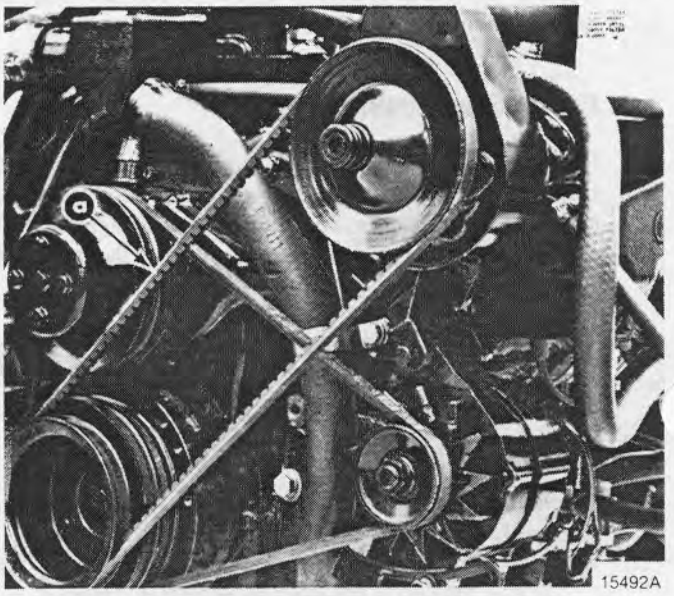
a - Belt Should Depress 1/4" (6mm)

Figure 4. MCM 898/228/260/330 with Low Mounted Pump



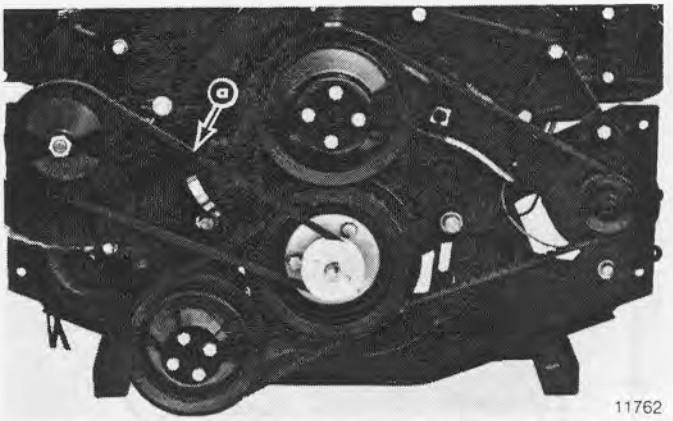
a - Belt Should Depress 1/4" (6mm)

Figure 5. MCM 898/228/260 with High Mounted Pump



a - Belt Should Depress 1/2" (13mm)

Figure 6. MCM 330 (B-W)



a - Belt Should Depress 1/4" (6mm)

Figure 7. Hi-Performance Power Steering Models

FLUSHING COOLING SYSTEM

If engine is operated in salty, polluted or mineral-laden waters, cooling system should be flushed periodically (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Cooling system also should be thoroughly flushed prior to storage.

⚠WARNING

When flushing cooling system with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby.

IMPORTANT: DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

IMPORTANT: If cooling system is to be flushed with boat in the water, water inlet valve (if so equipped) must be closed, or water inlet hose MUST BE disconnected and plugged to prevent water from flowing into boat.

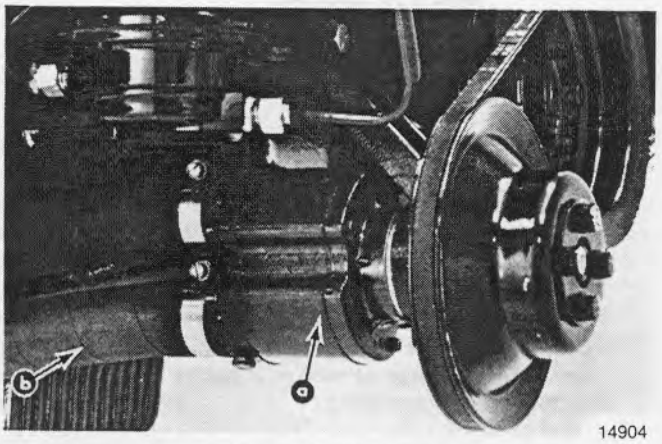
IMPORTANT: If boat is in the water, do not open water inlet valve until engine is to be restarted, to prevent contaminated water from flowing back into engine.

⚠CAUTION

Watch temperature gauge at dash to ensure that engine does not overheat.

BELT DRIVEN SEAWATER PICKUP PUMP

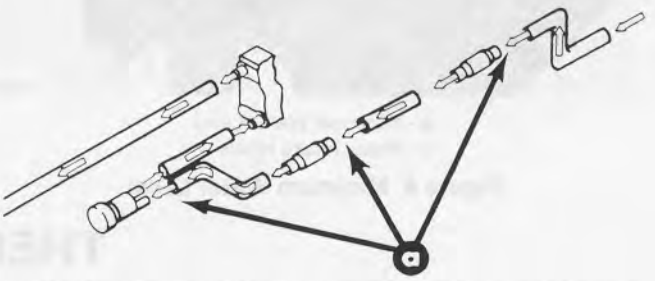
1. Loosen hose clamp and remove water inlet hose at location shown in Figure 1 or 2.



a - Seawater Pickup Pump
b - Seawater Inlet Hose

Figure 1. All V-8 Engines Except MCM 370/400 and Hi-Performance 454 CID Engines.

IMPORTANT: MCM 898/898R/228/228R/260/260R Engines: if engine has a Closed Cooling system or is a Drive Shaft Extension model refer to Figure 3 also, if cooling system is going to be flushed with boat out of the water. Two independent water connects are required on these models.

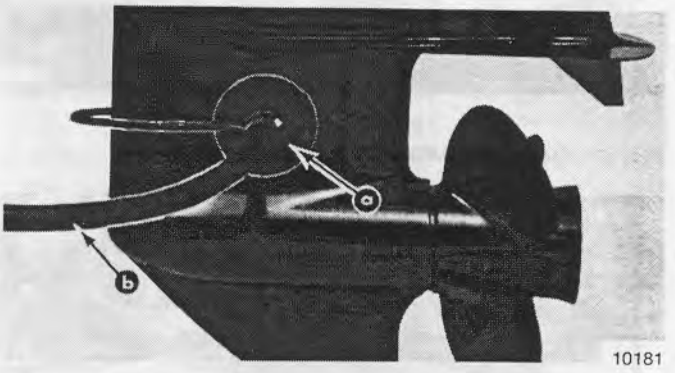


a - Disconnect Hose - Cooling Water Must Flow Thru Cooler(s) if Engine is so Equipped

Figure 2. MCM 370/400 and Hi-Performance Engines

3. Partially open water tap (approx. ½ maximum capacity) and allow cooling system to fill completely. Cooling system is full when water is discharged thru the exhaust. DO NOT use full water tap pressure.
4. Place the remote control lever in neutral position and start the engine. Operate engine at idle speed in neutral gear for 10 minutes or until discharge water is clear, then stop engine.
5. Shut off water tap. Remove flushing connector from pump inlet and reconnect water inlet hose. Be sure to tighten clamp securely.

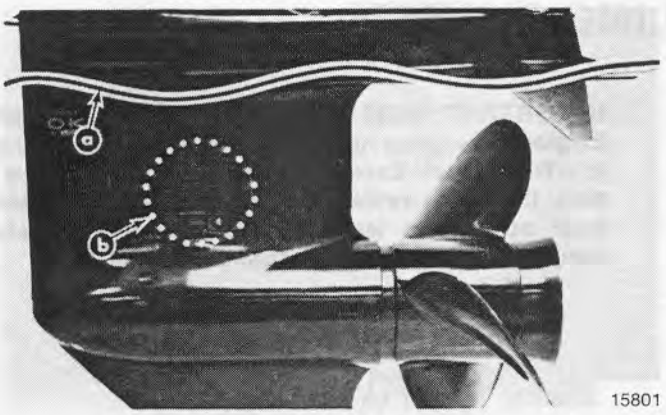
STERN DRIVE UNIT SEAWATER PICKUP PUMP



a - Flush Device
b - Garden Hose

Figure 3. Flush Device on Stern Drive

1. Install Flush Device and connect garden hose between it and water tap. (Figure 3)
2. Salt water areas and boat in the water:
   a. Raise stern drive unit to full trailer position.
   b. Install flush device over water intake holes. (Figure 4)
   c. Lower stern drive unit to full down position.



a - Minimum Water Level
b - Water Intake Holes

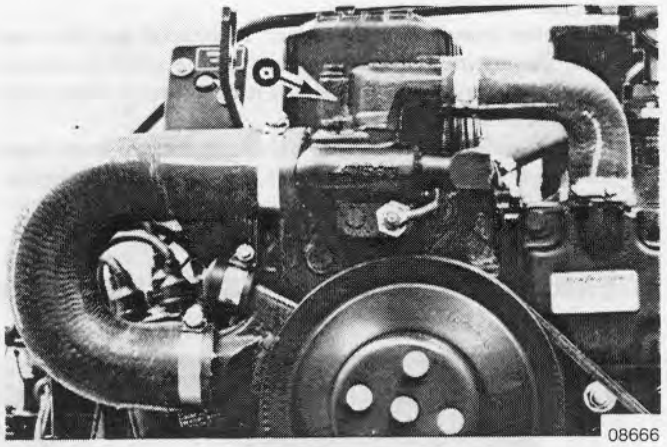
Figure 4. Minimum Water Level

3. Partially open water tap (approx. ½ maximum capacity) and allow cooling system to fill completely. Cooling system is full when water is discharged thru the propeller. DO NOT use full water tap pressure.
4. Place remote control in neutral position and start engine. Watch temperature gauge on instrument panel to ensure that engine does not overheat.
5. Stop engine, turn off water tap and remove Flush Device.

THERMOSTAT

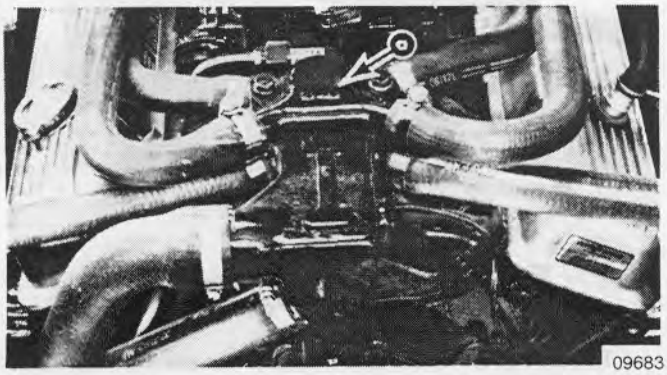
REMOVAL

1. Drain water from cylinder block and exhaust manifold(s).
2. Disconnect hose(s) from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket. (Figures 1, 2 or 3)
4. Remove thermostat from thermostat housing or cover.



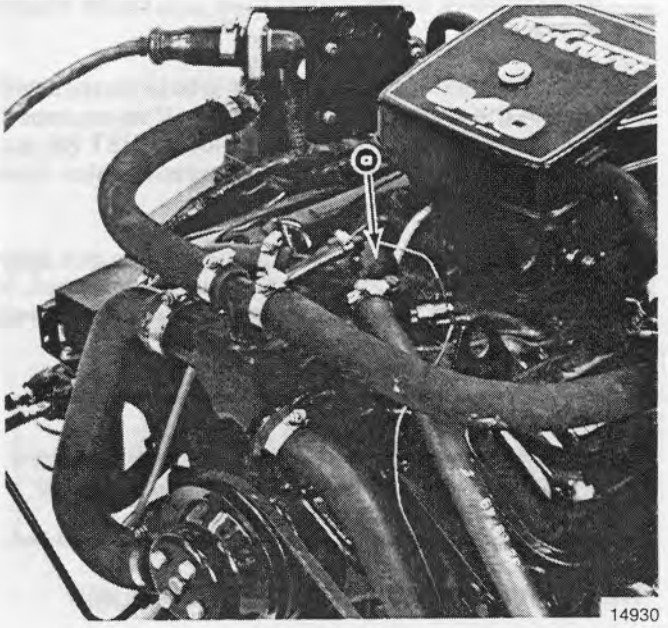
a - Thermostat Cover

Figure 1. MCM 120/140/165



a - Thermostat Housing Cover

Figure 2. MCM 898/228/260/330/370/400/ Hi-Performance 454 CID Engines and MIE 228/255/330

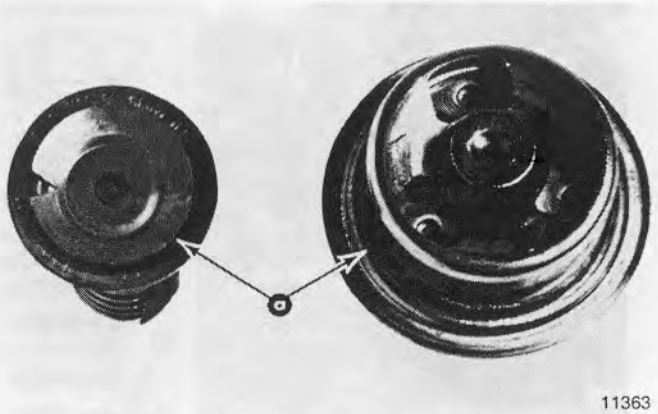


a - Thermostat Housing Cover

Figure 3. MCM 898R/228R/260R/330 (B-W) and MIE 230/260/340

TESTING

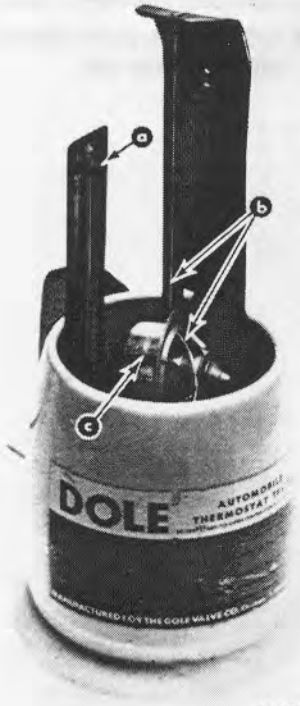
1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve (Figure 4) indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or 2 points around the valve perimeter is acceptable.)



a - Check for Light Leakage around Perimeter of Valve

Figure 4. Checking Typical Thermostats for Leakage

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown in Figure 5), as follows:
   a. Fill tester to within 1" (25mm) of top with tap water. DO NOT use distilled water.
   b. Open thermostat valve and insert nylon string. Position thermostat on string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.
   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. DO NOT allow thermometer to touch container.



a - Thermometer
b - Nylon String
c - Thermostat

Figure 5. Thermostat Tester

IMPORTANT: When performing Steps d-thru-f, water MUST BE agitated throughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat MUST open at specified temperature stamped on thermostat.
   e. Continue to heat water until a temperature 25° F (14° C) above temperature specified on thermostat is obtained. Thermostat valve MUST BE completely open at this temperature.
   f. Unplug tester and allow water to cool to a temperature 10° F (5° C) below specified temperature on thermostat. Thermostat MUST BE completely closed at this temperature
   g. Replace a thermostat that fails to meet all of the preceding tests.

INSTALLATION

1. Clean gasket surfaces on thermostat cover and thermostat housing.
2. **MCM/MIE V-8 Engines:** If thermostat housing was disturbed during removal of thermostat, remove thermostat housing and replace thermostat housing to intake manifold gasket. Before installing, coat both sides of new gasket (without continuity rivets) with Perfect Seal.

IMPORTANT: If gasket has continuity rivets, DO NOT coat with Perfect Seal or Audio Warning temperature switch may not work properly.

3. Place thermostat in thermostat housing with thermostatic element end toward housing. Be sure to position thermostat so that mounting flange fits into recess in thermostat housing. (Figure 6, 7 or 8)

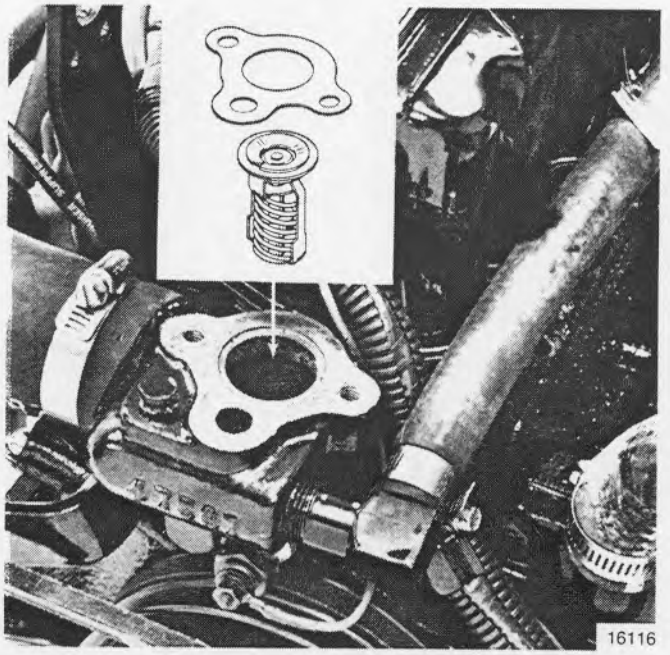
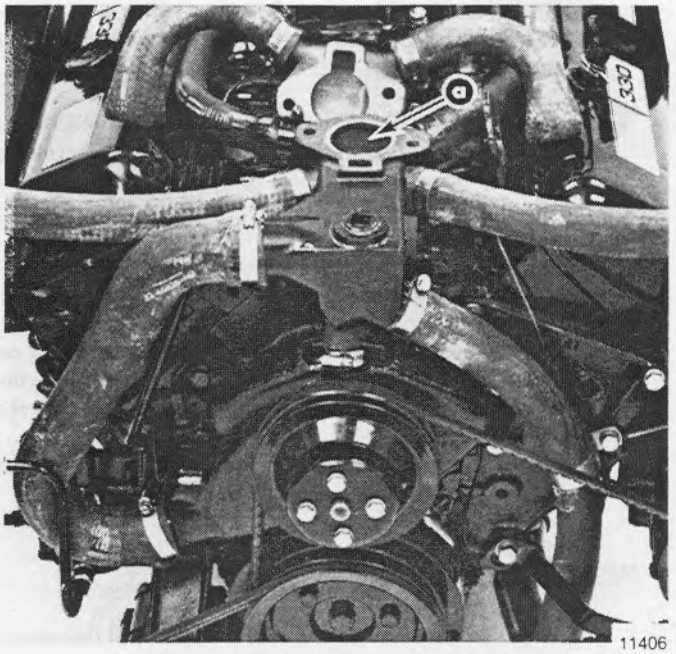


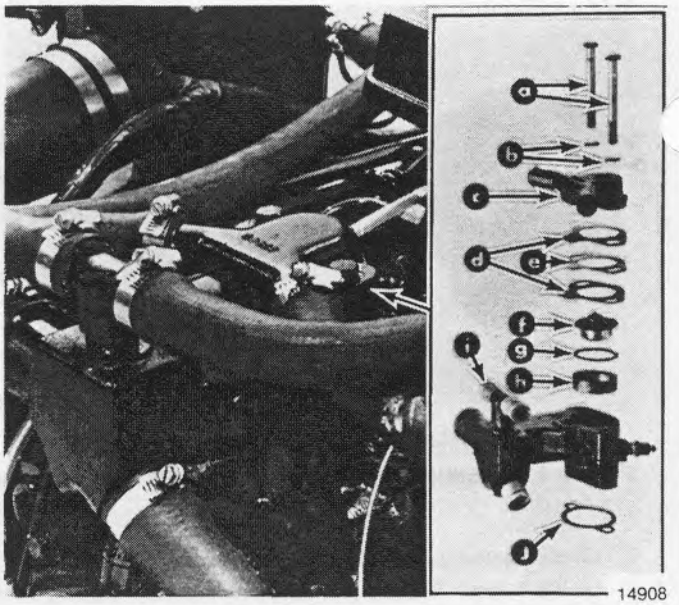
Figure 6. MCM 120/140/165



a - Thermostat Location

Figure 7. MCM 898/228/260/330/370/400/ Hi-Performance 454 CID Engines and MIE 228/255/330

4. Coat both sides of new thermostat cover to thermostat housing gasket with Perfect Seal and position on thermostat housing. Reinstall thermostat cover and torque bolts to specifications.
5. Reconnect hose(s) to thermostat cover.
6. Start engine and inspect for leaks.



a - Screws
b - Lockwashers
c - Cover
d - Upper Gaskets (Coat Both Sides with Perfect Seal)
e - Stainless Steel Separator Plate
f - Thermostat
g - Cork Gasket
h - Sleeve (Install with Turned-In Edge Up)
i - Thermostat Housing
j - MCM 898R/228R/260R and MIE 230/260: Lower Gasket (Coat Both Sides with Perfect Seal)
MCM 330 (B-W) and MIE 340: Lower Gasket with Continuity Rivets (DO NOT Coat with Perfect Seal)

Figure 8. MCM 898R/228R/260R/330 (B-W) and MIE 230/260/340

OUT-OF-SEASON STORAGE (DRAINING)

DRAINING PRECAUTIONS

IMPORTANT: If the possibility of freezing exists, cooling system MUST BE drained to prevent freeze damage to cooling system. Cooling system also should be drained if boat is to be stored for an extended period of time to prevent corrosion damage.

⚠CAUTION

Cooling system, MUST BE completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine.

⚠CAUTION

If boat is in the water, water inlet valve (if so equipped) MUST be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose MUST BE left disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve MUST BE opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcocks, removal of petcock may be required so that wire can be inserted completely into drain hole.

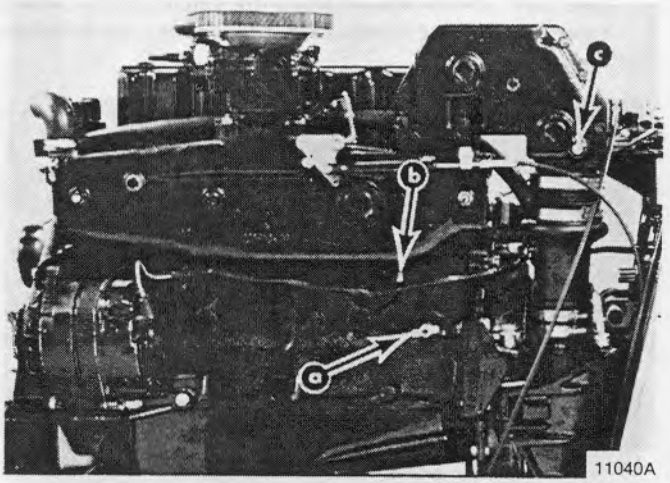
IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Perfect Seal on threads. NEVER leave drain plugs out during stor age.

Note: If possible, place a container under drains to prevent water from draining into boat.

MCM 120/140

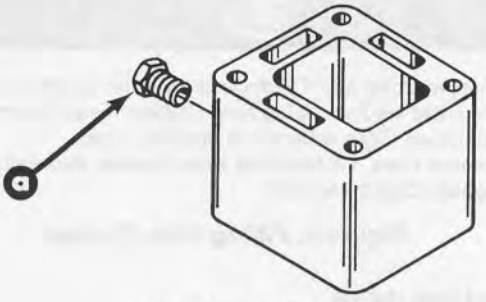
NOTICE
Refer to "Draining Precautions", in this section, BEFORE PROCEEDING.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figure 1, 2, and 3.



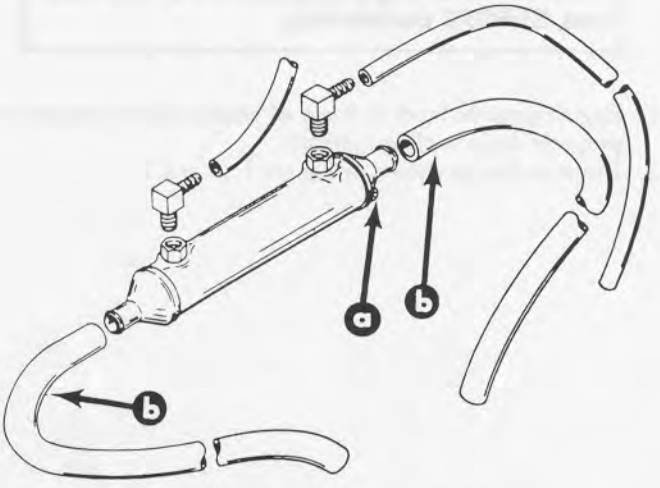
a - Petcock - Open
b - Drain Plug - Remove
c - Drain Plug - MCM 140 Only, MCM 120 Has Self Draining Exhaust Elbow

Figure 1. Engine Drain Locations



a - Drain Plug - Remove

Figure 2. 3" or 6" Risers (If Equipped)

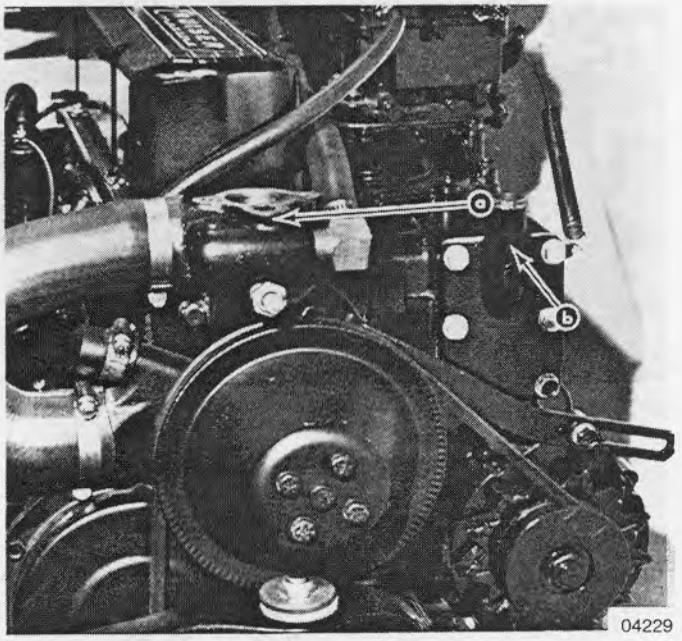


a - Drain Plug - Remove
b - Cooler Without Drain Plug - Remove Hoses

Figure 3. Power Steering Fluid Cooler (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcock.

4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 4.



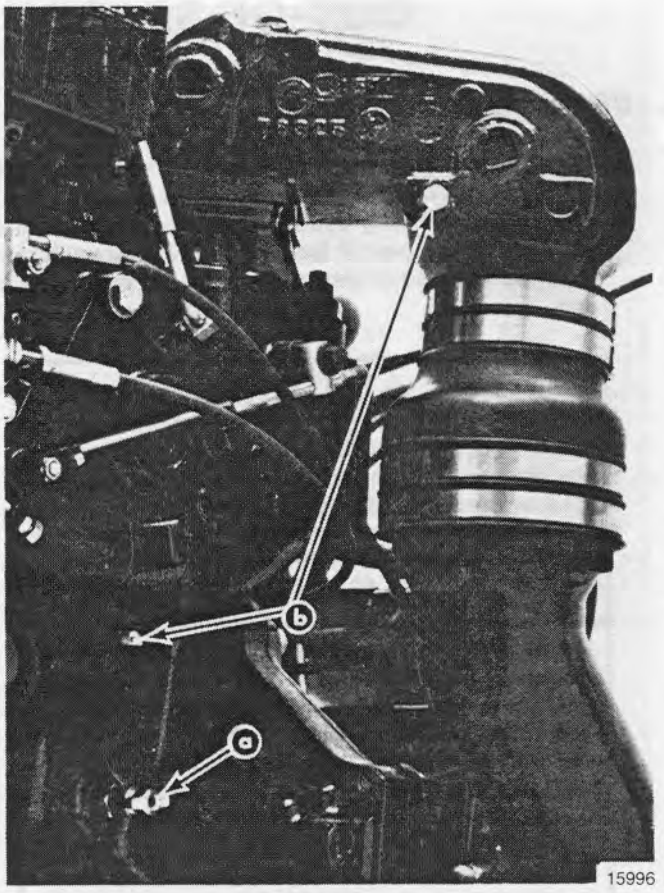
a - Remove Cover and Thermostat. Fill with Coolant until Block and Head are Full. Using New Gasket, Install Thermostat and Cover. Torque Screw to Specifications
b - Remove Hose. Fill Manifold with Coolant. Reinstall Hose and Tighten Clamp Securely

Figure 4. Filling With Coolant

MCM 120R/140R

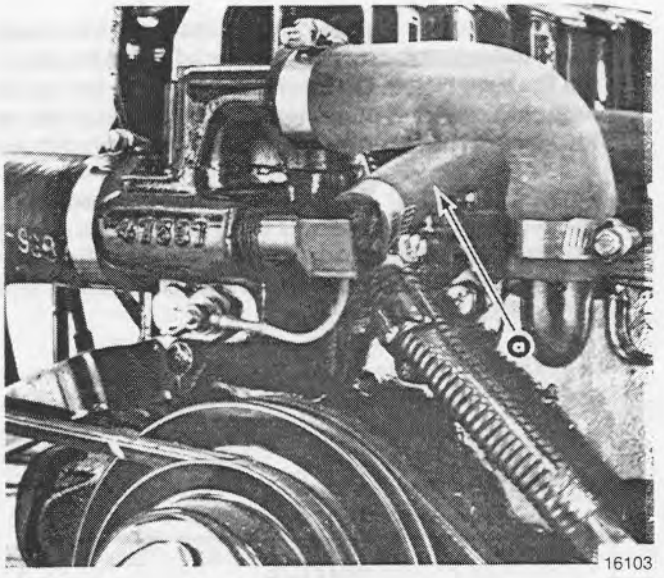
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figure 1, 2, and 3.



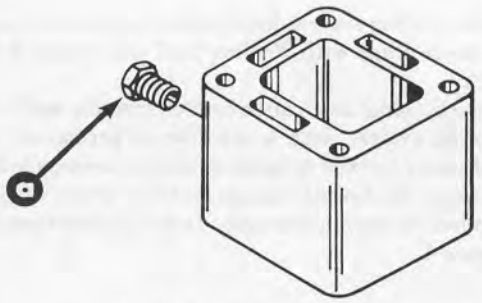
a - Petcock - Open
b - Drain Plugs - Remove

Figure 1. Engine Drain Locations



a - Remove Hose and Lower to Drain

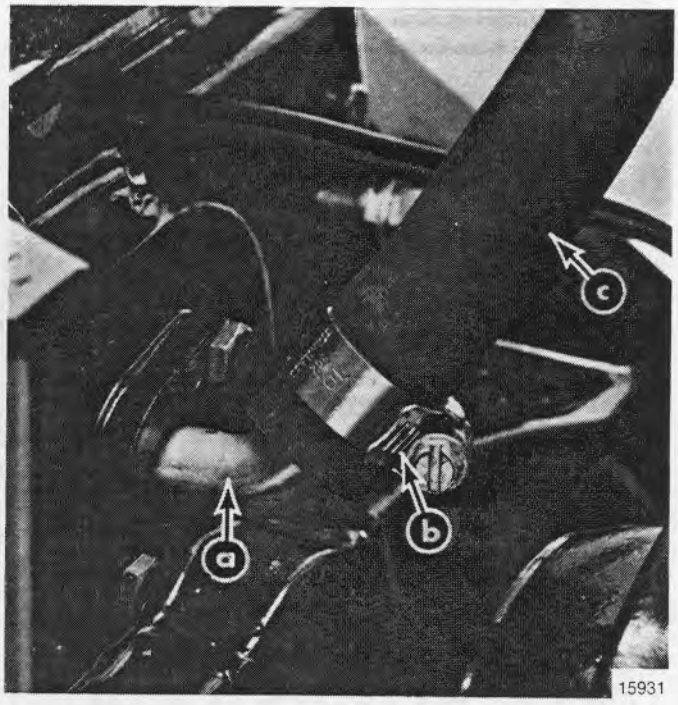
Figure 2. Draining Inlet Hose



a - Drain Plug - Remove

Figure 3. 3" or 6" Risers (If Equipped)

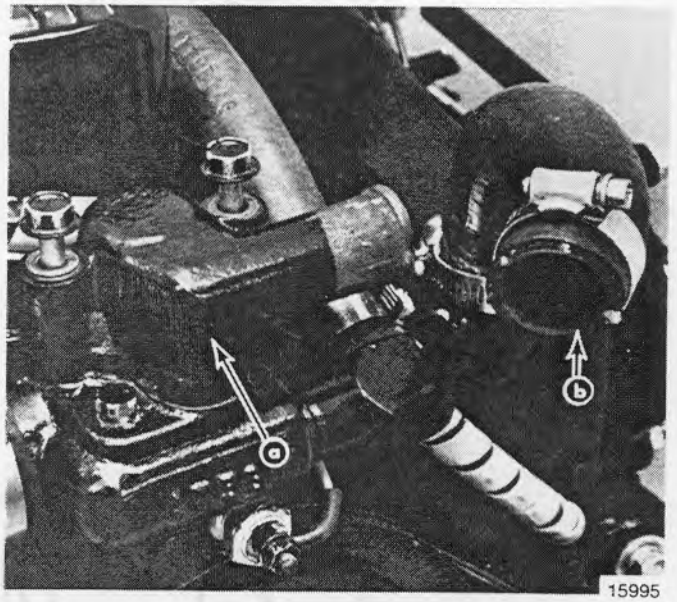
3. **MCM 120R/140R Drive Shaft Extension Models:** Disconnect water inlet hose from gimbal housing. Lower to drain hose (and Power Steering fluid cooler, if equipped). (Figure 4)



a - Water tube
b - Hose Clamp (Tighten Securely)
c - Water Hose

Figure 4. Water Hose Connection

4. **Power Steering Models:** Fluid Cooler will drain back thru stern drive unit.
5. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcock.
6. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 5.



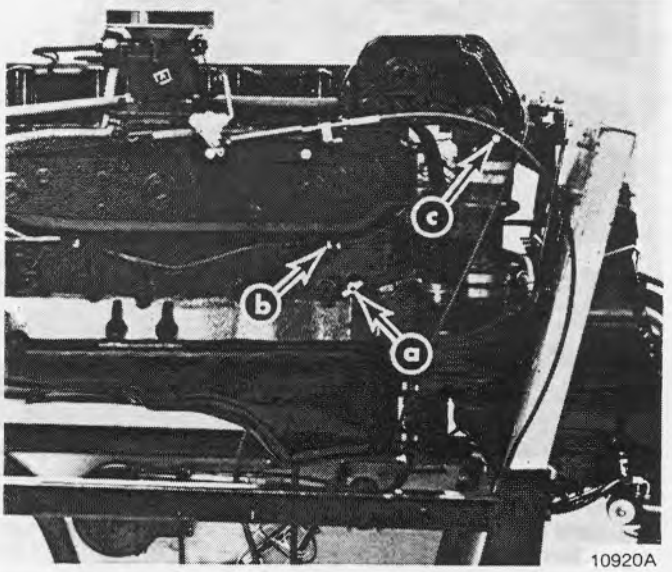
a - Remove Cover and Thermostat. Fill with Coolant until Block and Head are Full. Using New Gasket, Install Thermostat and Cover. Torque Screw to Specifications
b - Remove Hose. Fill Manifold with Coolant. Reinstall Hose and Tighten Clamp Securely

Figure 5. Filling With Coolant

MCM 165

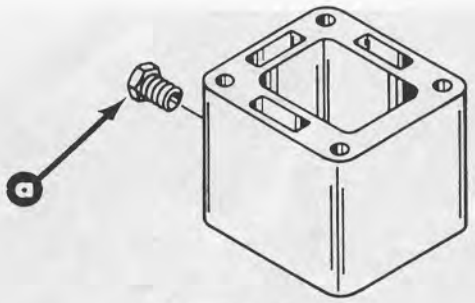
NOTICE
Refer to "Draining Precautions', in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figure 1, 2, and 3.



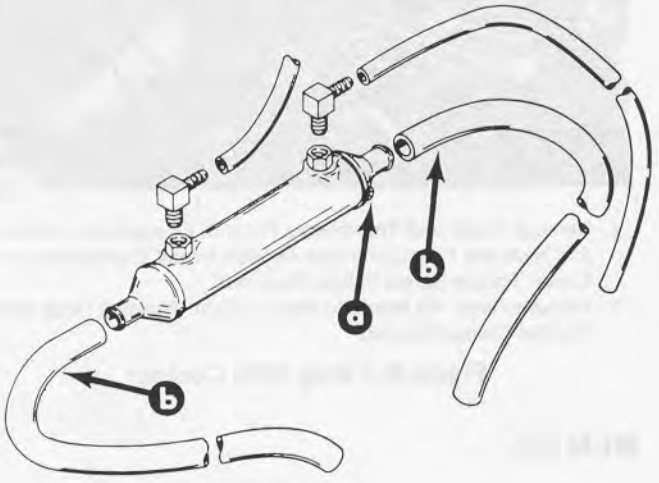
a - Petcock - Open
b - Drain Plug - Remove
c - Drain Plug - Remove

Figure 1. Engine Drain Locations



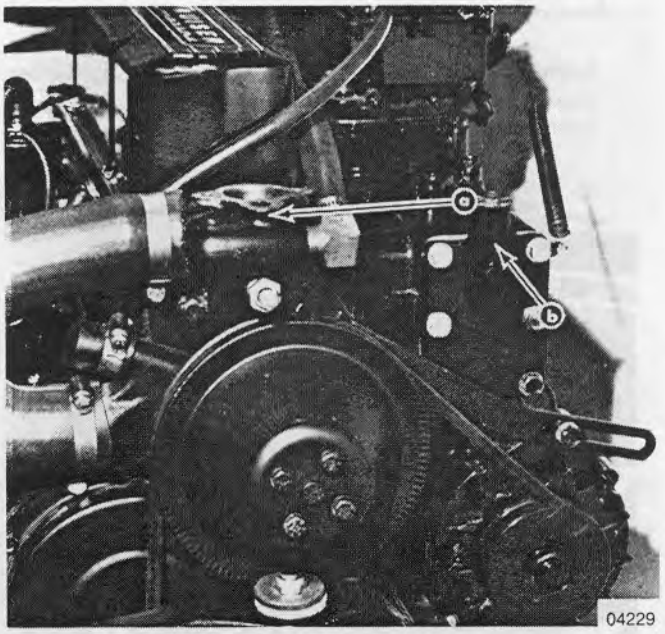
a - Drain Plug - Remove

Figure 2. 3″ or 6″ Risers (If Equipped)



a - Drain Plug - Remove
b - Cooler Without Drain Plug - Remove Hoses

Figure 3. Power Steering Fluid Cooler (If Equipped)



a - Remove Cover and Thermostat. Fill with Coolant until Block and Head are Full. Using New Gasket, Install Thermostat and Cover. Torque Screw to Specifications
b - Remove Hose. Fill Manifold with Coolant. Reinstall Hose and Tighten Clamp Securely

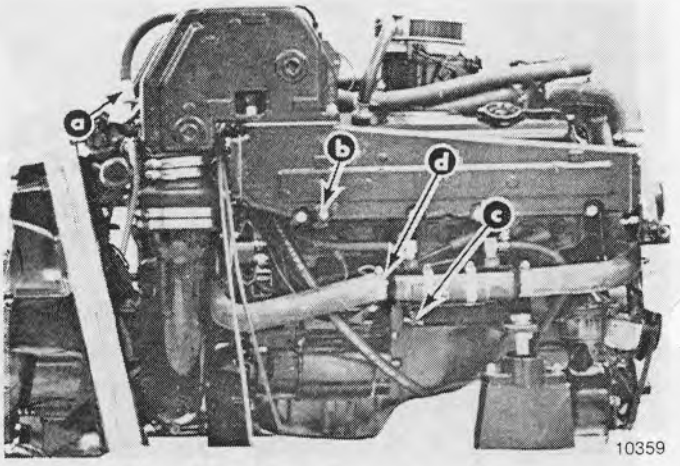
Figure 4. Filling with Coolant

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcock.
4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 4.

MCM 898/228/260

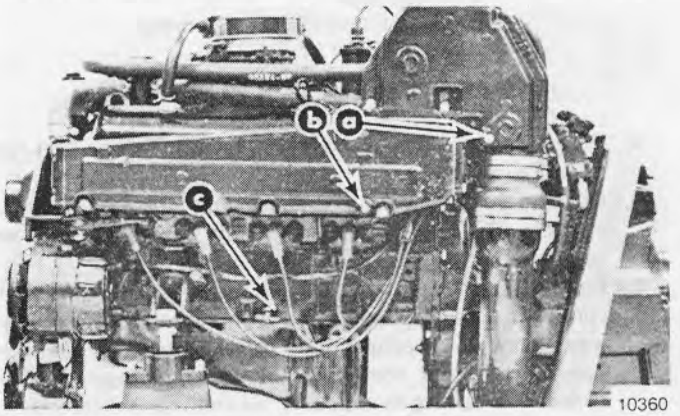
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 1, 2, and 3.



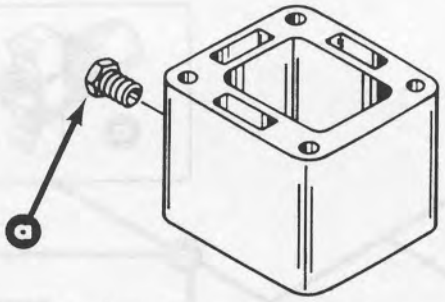
a - Drain Plug (Hidden) - Remove
b - Drain Plug - Remove
c - Petcock - Open
d - Power Steering Fluid Cooler - Remove Drain Plug or Hose

Figure 1. Engine Drain Location - Starboard Side



a - Drain Plug - Remove
b - Drain Plug - Remove
c - Petcock - Open

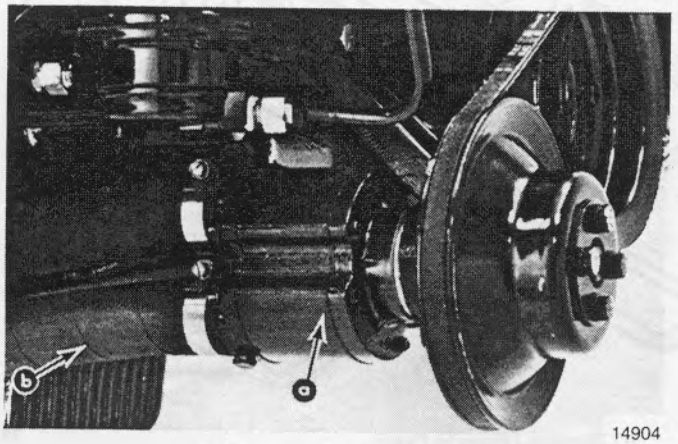
Figure 2. Engine Drain Location - Port Side



a - Drain Plug - Remove

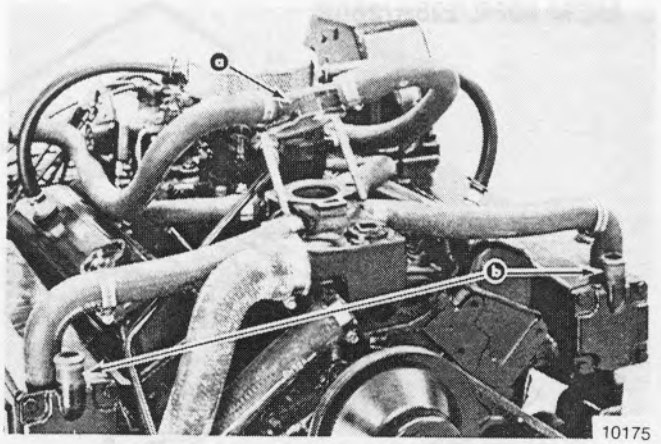
Figure 3. 3″ or 6″ Risers (If Equipped)

3. **MCM 898/228/260 Driveshaft Extension Models:** Remove seawater inlet hose. (Figure 4)



a - Seawater Pickup Pump
b - Hose

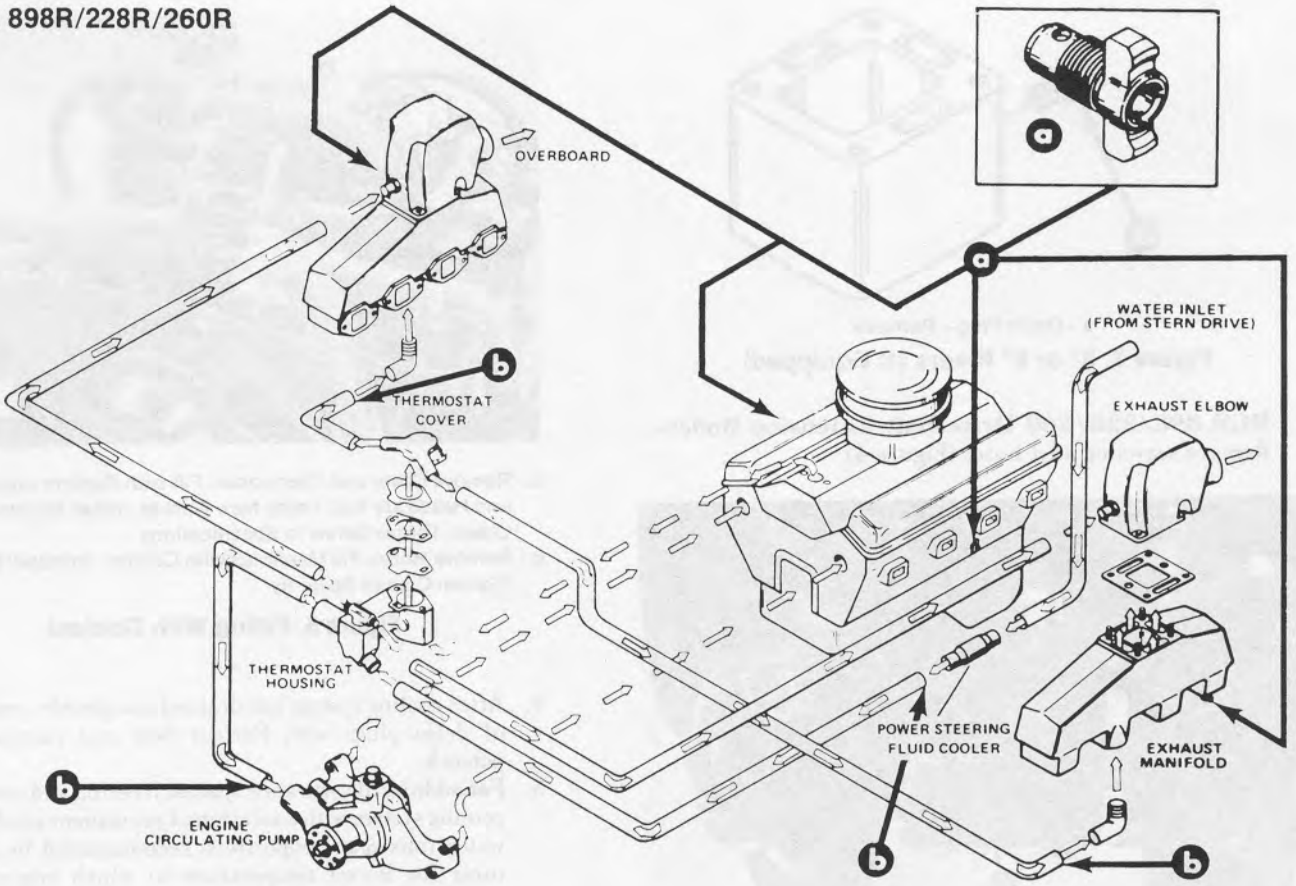
Figure 4. Driveshaft Extension Models



a - Remove Cover and Thermostat. Fill with Coolant until Block and Heads are Full. Using New Gasket, Install thermostat and Cover. Torque Screw to Specifications
b - Remove Hoses. Fill Manifolds with Coolant. Reinstall Hose and Tighten Clamps Securely

Figure 5. Filling With Coolant

4. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcock.
5. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 5.

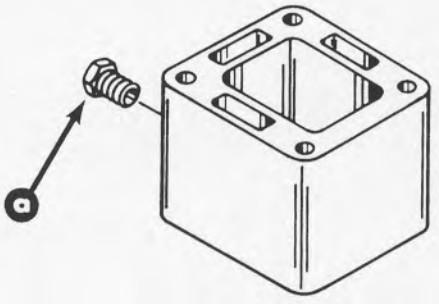


a - Petcocks (4) - Remove b - Remove Hoses to Drain 337-H

Figure 1. Engine Drain Locations

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

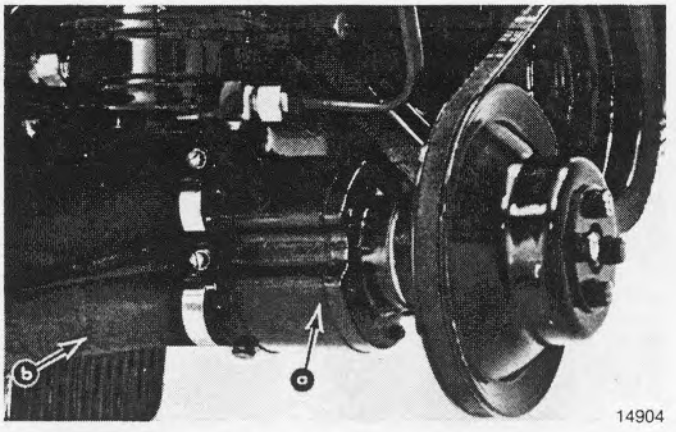
1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 1 and 2.



a - Drain Plug - Remove

Figure 2. 3" or 6" Risers (If Equipped)

3. **MCM 898R/228R/260R Driveshaft Extension Models:** Remove seawater inlet hose. (Figure 3)

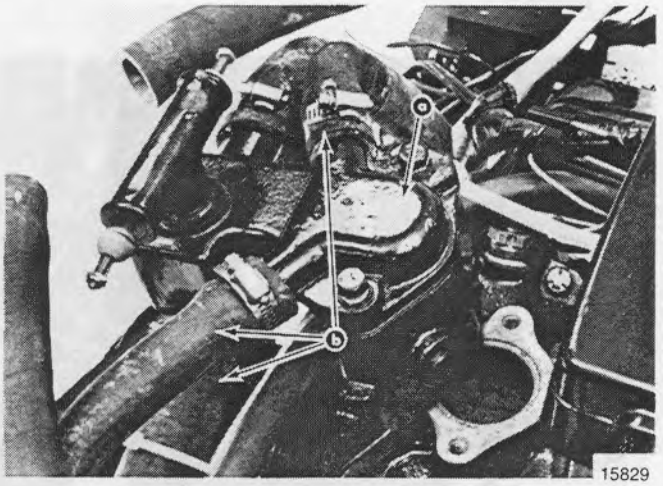


14904

a - Seawater Pickup Pump
b - Seawater Inlet Hose

Figure 3. Driveshaft Extension Models

4. After cooling system has drained completely, coat threads of drain plug(s) with Perfect Seal and reinstall. Close petcock and reconnect all hoses. Tighten clamps securely.
5. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommeded by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 4.



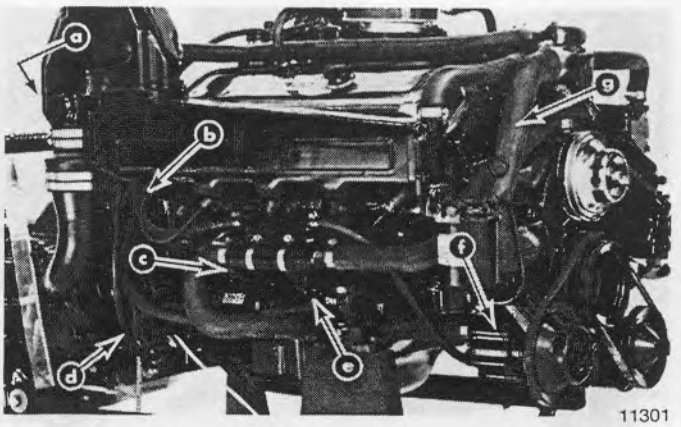
a - Remove Cover and Thermostat Housing. Fill with Coolant until Block and Heads are Full. Using New Gasket, Install Thermostat and Cover. Torque Screw to Specifications
b - Remove Hoses. Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely.

Figure 4. Filling With Coolant

MCM 330 with MERCURY MARINE TRANSMISSION

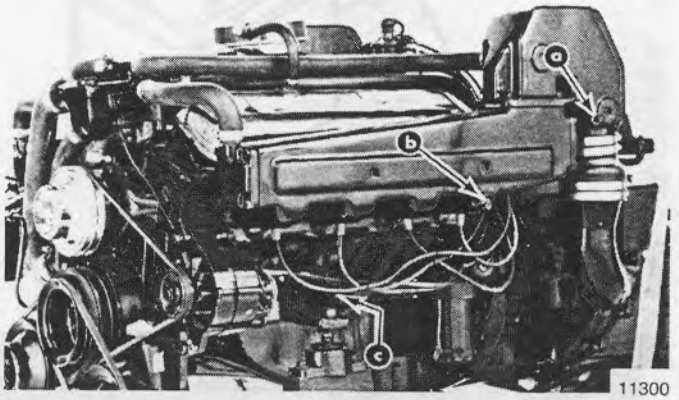
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine higher to properly drain cooling system.
2. Drain cooling system as shown in Figures 1, 2, 3, 4 and 5.



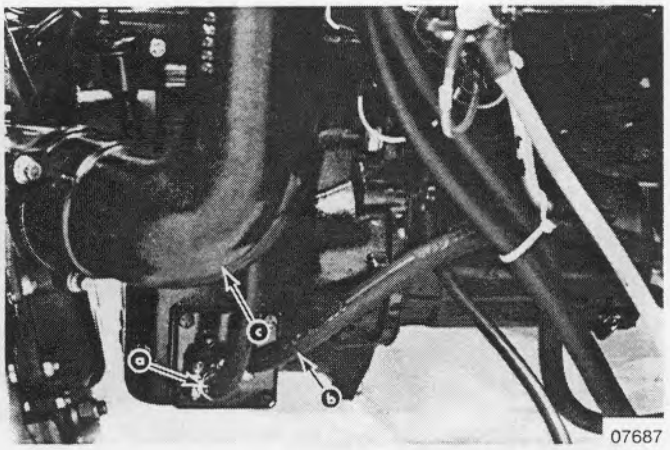
a - Drain Plug (Hidden) - Remove
b - Drain Plug - Remove
c - Power Steering Fluid Cooler Drain Plug or Hose - Remove
d - Transmission Oil Cooler See Figure 3
e - Petcock - Open
f - Seawater Pickup Pump
g - Hose - Remove

Figure 1. Engine Drain Locations - Starboard Side



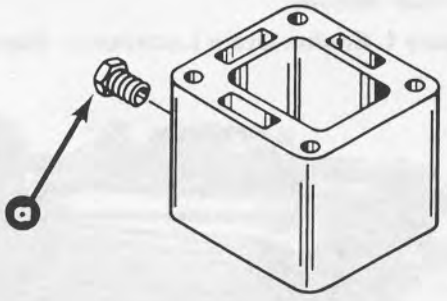
a - Drain Plug - Remove
b - Drain Plug - Remove
c - Petcock (Hidden) - Open

Figure 2. Engine Drain Locations - Port Side



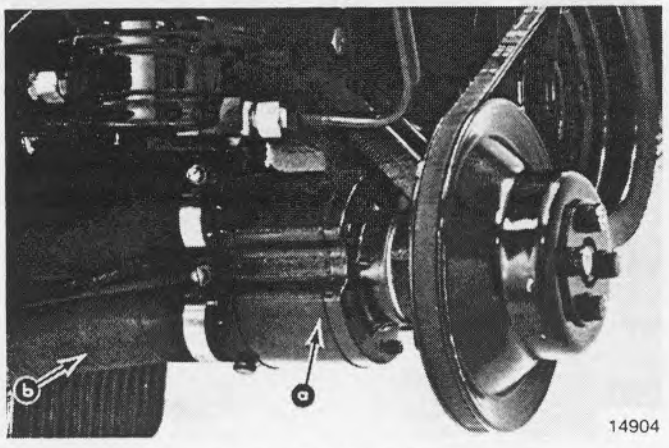
a - Hose - Disconnect
b - Hose - Disconnect From Seawater Pump and Blow Air Thru it.
c - Starboard Exhaust Pipe

Figure 3. Transmission Fluid Cooler



a - Drain Plug - Remove

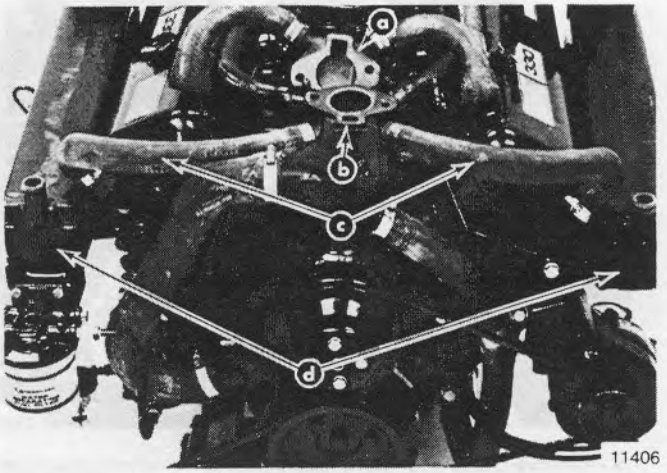
Figure 4. 3" or 6" Risers (If Equipped)



a - Seawater Pickup Pump
b - Hose - Remove

Figure 5. Seawater Pickup Pump

3. After cooling system has drained completely, coat thread of drain plugs with Perfect Seal and reinstall. Close petcocks and reconnect all hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 6.



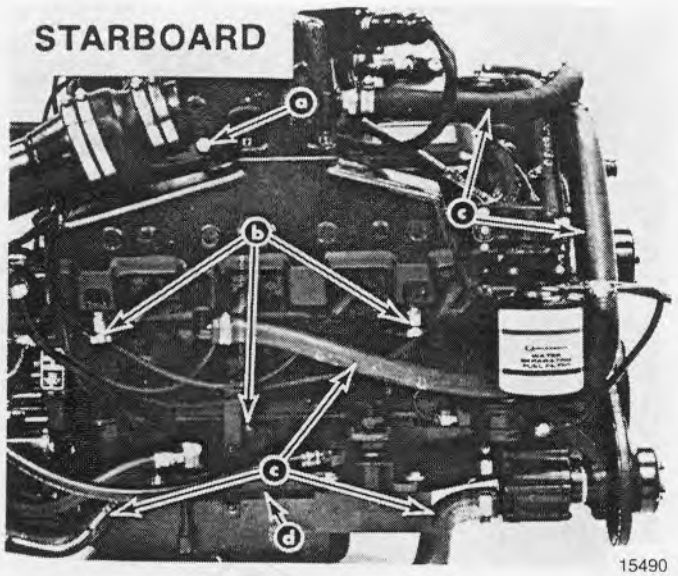
a - Remove Cover and Thermostat. Fill with Coolant until Block and Heads are Full. Using New Gasket, Install Thermostat and Cover. Torque Screws to Specifications
b - Housing
c - Hoses
d - End Caps. Remove Hoses, Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely

Figure 6. Filling With Coolant

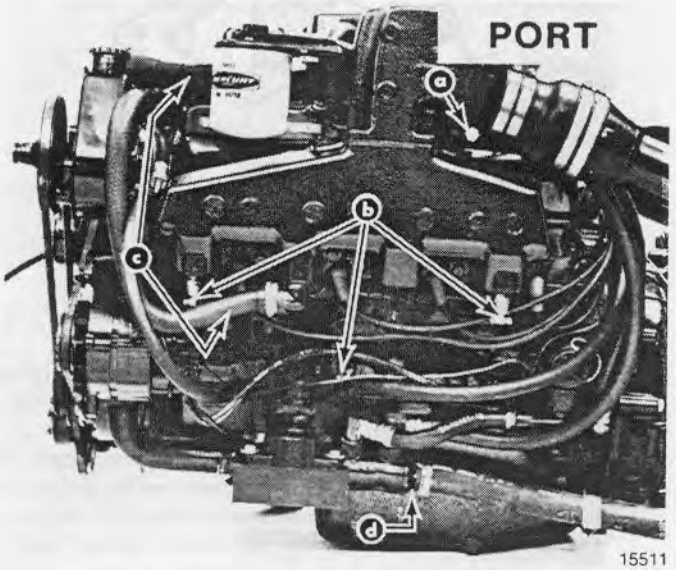
MCM 330 (B-W)

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 1 and 2.



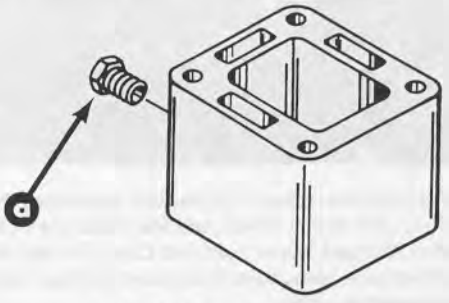
15490



15511

a - Drain Plugs (2)
b - Petcocks (6) - Remove
c - Hoses (7) - Remove and Lower to Drain
d - Fluid and Oil Coolers (2) - Remove Drain Plugs or Hoses to Drain

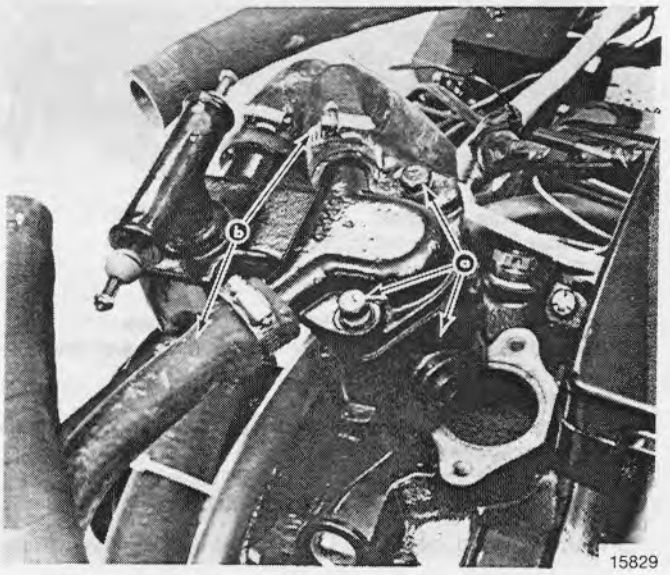
Figure 1. Engine Drain Locations



a - Drain Plug - Remove

Figure 2. 3" or 6" Risers (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcocks and reconnect all hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacture for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 3.



15829

a - Remove Screws and Thermostat Housing. Fill with Coolant until Block and Heads are Full. Using New Gasket, with Continuity Rivets (Do Not Use Perfect Seal), Install Housing. Torque Screws to Specifications
b - Remove Hoses and Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely.

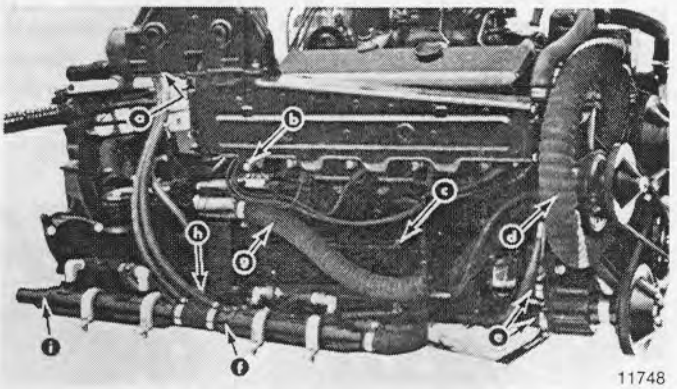
Figure 3. Filling With Coolant

MCM 370/400/400 CYCLONE/475 TURBO

NOTICE
Refer to "Draining Precautions", in this section, BEFORE starting work.

NOTICE
The draining instructions given are for the models listed above. MCM 440 Cyclone/460 Cyclone models can be drained by following these instruction, HOWEVER the exhaust systems on these engines may be different and they are not shown. It is recommended that the person doing the draining, removes all trapped water to prevent freeze damage. Also, a mixture of permanent antifreeze and water (mixed to proportions recommended by manufacture for lowest temperature to which engine will be exposed during storage), be put in these exhaust systems to give added protection.

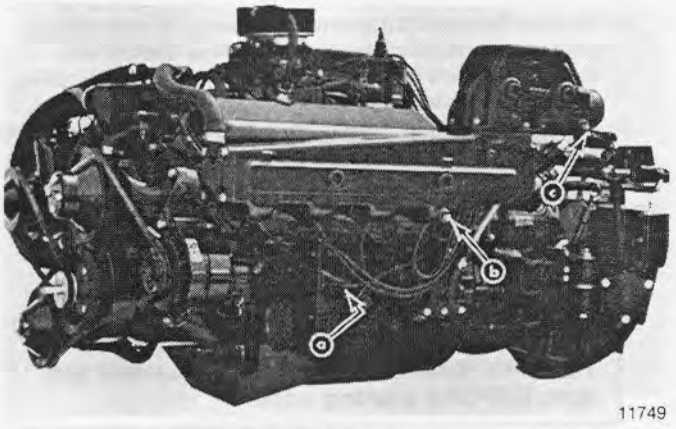
1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figure 1, 2, 3, 4 and 5.



11748

a - Drain Plug (Hidden)
b - Drain Plug
c - Drain Plug - Block
d - Hose - Remove
e - Seawater Pickup Pump Inlet and Outlet Hoses
f - Power Steering Fluid Cooler (May be Mounted on Engine) - Drain Plug or Remove Hose.
g - Hose - Remove
h - Transmission Fluid Cooler (Flywheel Housing Models), Drain Plug (Hidden)
i - Stringer Mounted Engine Oil Cooler (Flywheel Housing Models, Refer to Figure 4) - Drain Plug or Remove Hose

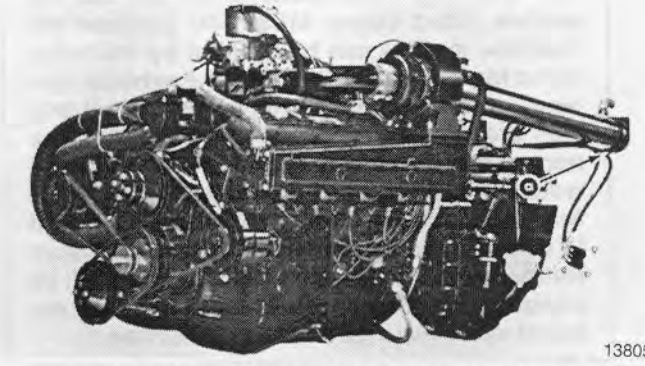
Figure 1. Engine Drain Locations - Starboard Side.



11749

a - Drain Plug - Block
b - Drain Plug
c - Drain Plug

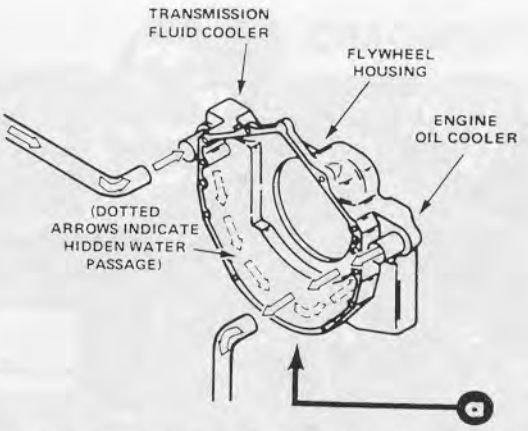
Figure 2. Engine Drain Locations - Port Side



13805

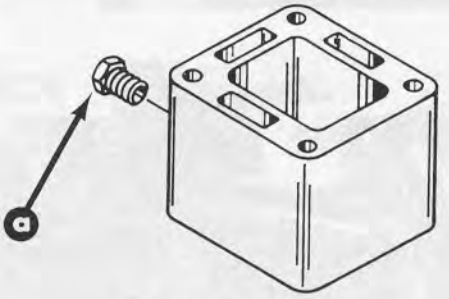
a - Exhaust Pipe Drain Plug (1 each Pipe) - Remove

Figure 3. MCM 475 Turbo



a - Drain Plug on Bottom of Flywheel Housing - Drains Both Coolers

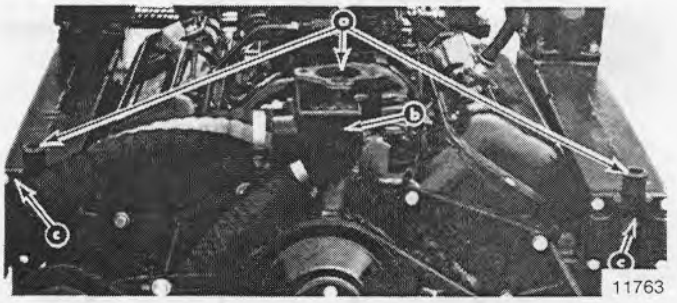
Figure 4. Dual Cooler Flywheel Housing



a - Draing Plug - Remove

Figure 5. 3" or 6" Risers (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect all hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacture for lowest temperature to which engine will be exposed to during storage). To fill cooling system refer to Figure 6.



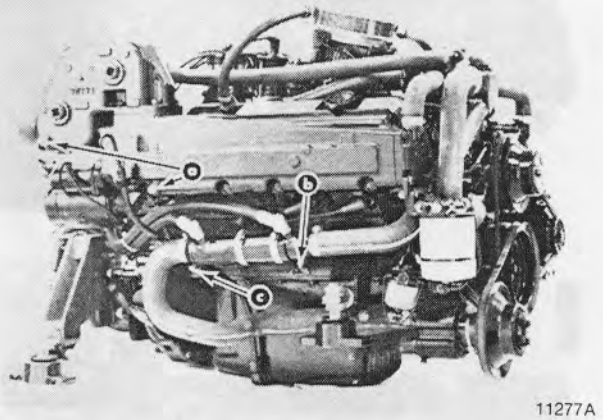
11763

a - Remove Screws, Cover, Thermostat and Hoses. Fill with Coolant until Block, Heads and Manifolds are Full. Using New Gasket Reinstall Thermostat and Cover. Torque Screws to Specifications. Reconnect Hoses and Tighten Clamps Securely
b - Thermostat Housing
c - Mainifolds

Figure 6. Filling With Coolant

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

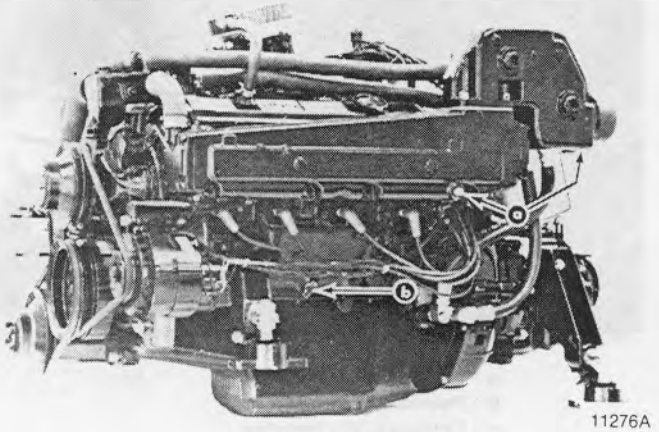
1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 1, 2, 3, 4 and 5.



11277A

a - Drain Plugs (2) - Remove
b - Petcock - Open
c - Remove Drain Plug or Hose

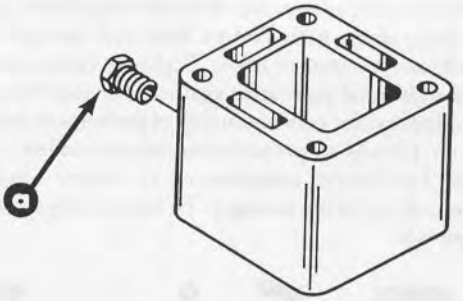
Figure 1. Engine Drain Location - Starboard Side



11276A

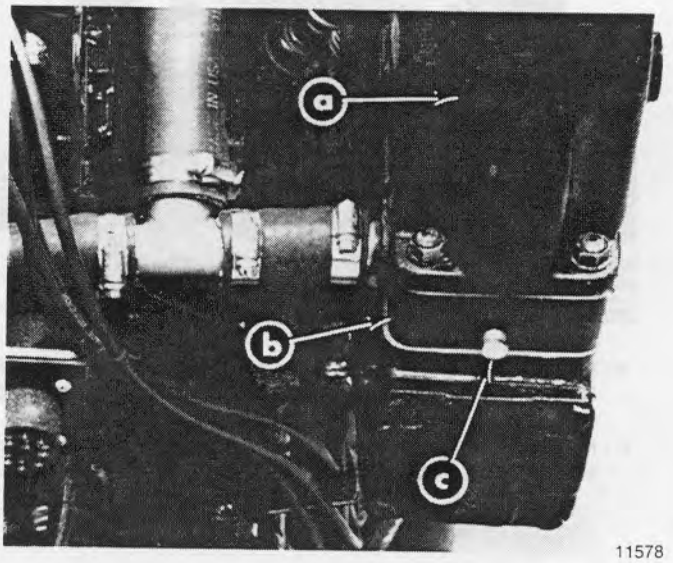
a - Drain Plugs (2) - Remove
b - Petcock - Open

Figure 2. Engine Drain Locations - Port Side



a - Drain Plug - Remove

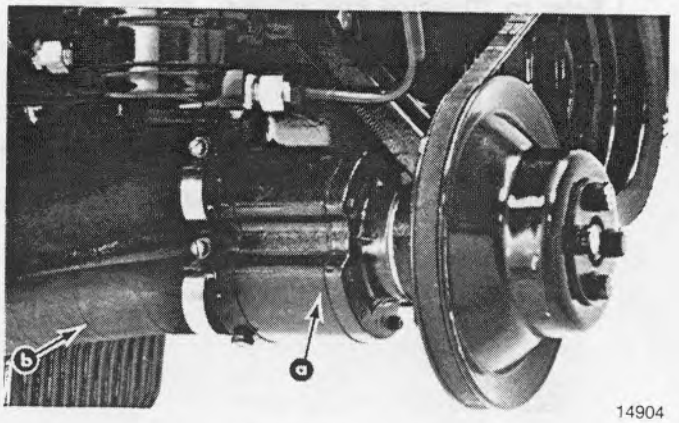
Figure 3. 3" or 6" Risers (If Equipped)



11578

a - Exhaust Elbow
b - Water Distribution Block
c - Drain Plug - Remove

Figure 4. Water Distribution Block (If Equipped)

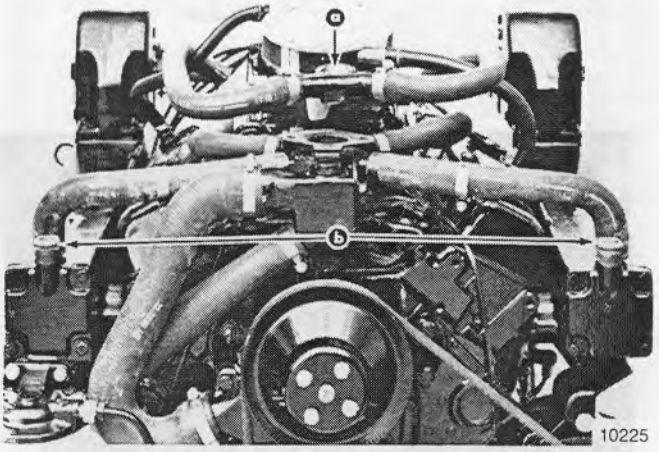


14904

a - Seawater Pickup Pump
b - Hose - Remove

Figure 5. Seawater Pickup Pump

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcocks and reconnect hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacture for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 6.



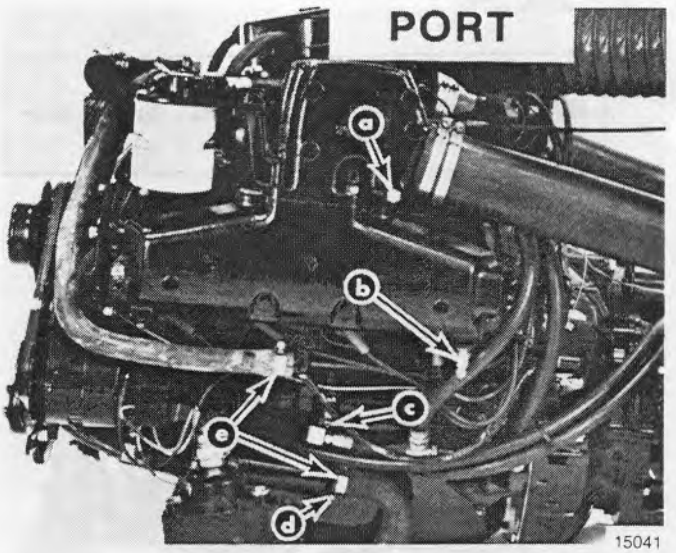
a - Remove Screws, Cover and Thermostat. Fill with Coolant until Block and Heads are Full. Using New Gasket, Install Thermostat and Cover. Torque Screws to Specifications
b - Remove Hoses and Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely

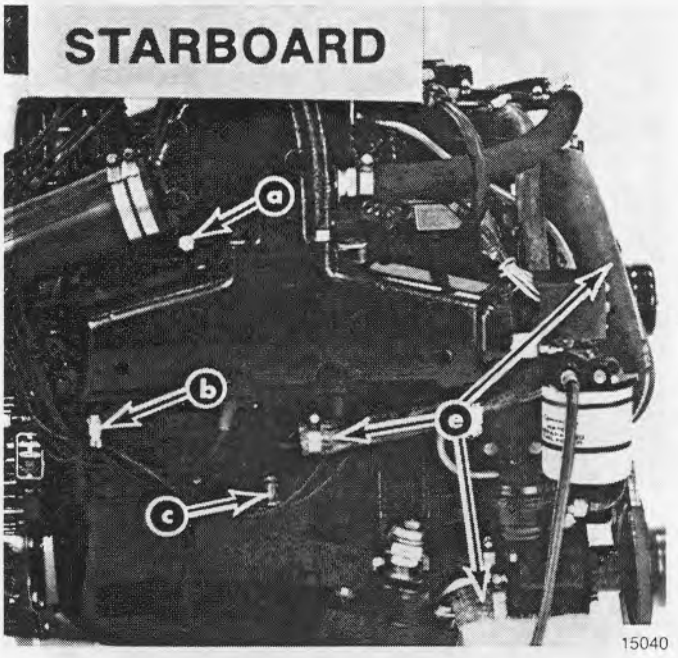
Figure 6. Filling With Coolant

MIE 230/260

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

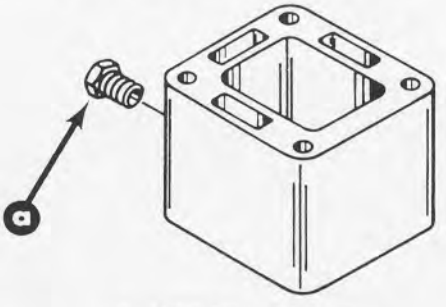
1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 1 and 2.





a - Drain Plug (2) - Remove
b - Petcocks (2) - Remove
c - Petcocks (2) - Remove
d - Remove Drain Plug or Hose
e - Hoses (5) - Remove. Lower to Drain

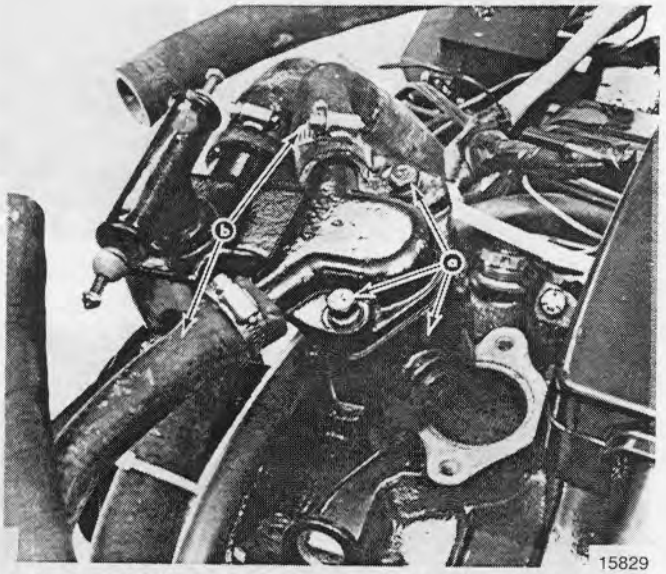
Figure 1. Engine Drain Locations



a - Drain Plug - Remove

Figure 2. 3" or 6" Risers (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcocks and reconnect hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacture for lowest temperature to which engine will be exposed to during storage). To fill cooling system, refer to Figure 3.



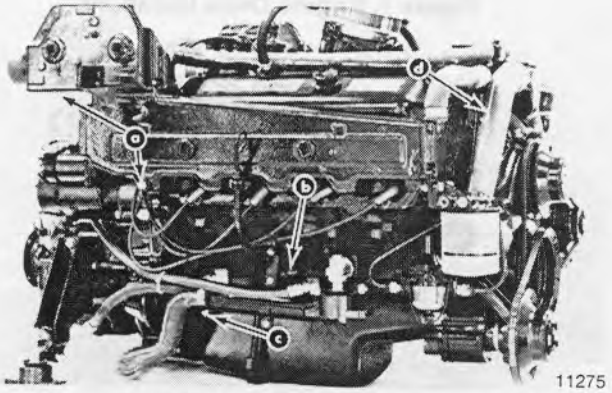
a - Remove Screws and Thermostat Housing. Fill with Coolant until Block and Heads are Full. Using New Gasket, Install Housing. Torque Screws to Specifications
b - Remove Hoses and Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely

Figure 3. Filling With Coolant

MIE 330

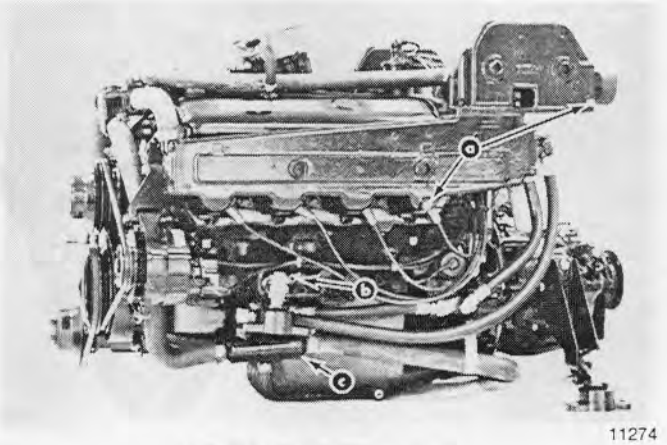
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 1, 2, 3, 4 and 5



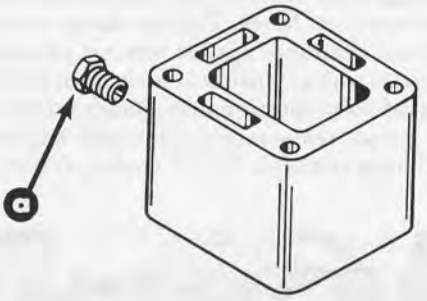
a - Drain Plugs (2) - Remove
b - Petcock - Open
c - Remove Drain Plug or Hose
d - Hose - Remove

Figure 1. Engine Draining Locations - Starboard Side



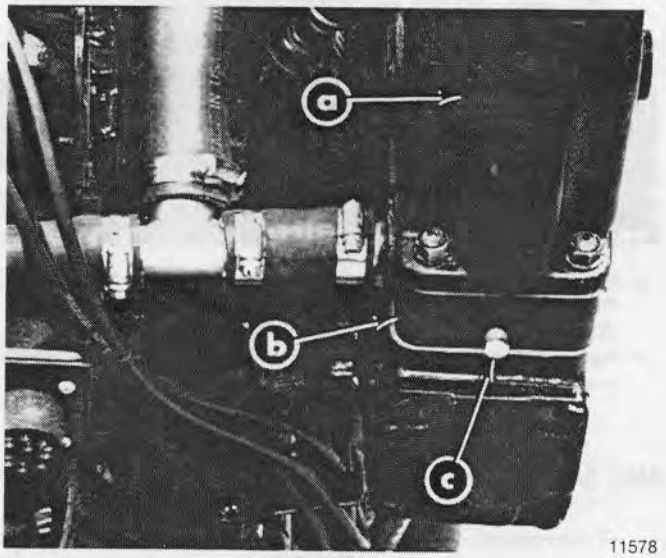
a - Drain Plugs (2) - Remove
b - Petcock (1) - Open
c - Remove Drain Plug or Hose

Figure 2. Engine Draining Locations - Port Side



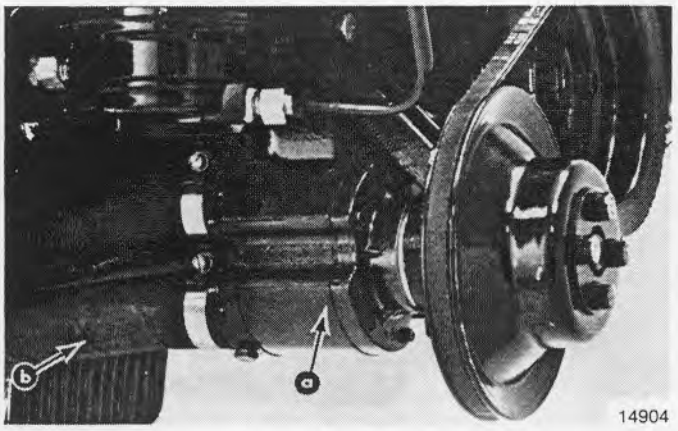
a - Drain Plug - Remove

Figure 3. 3" or 6" Risers (If Equipped)



a - Exhaust Elbow
b - Water Distribution Block
c - Drain Plug - Remove

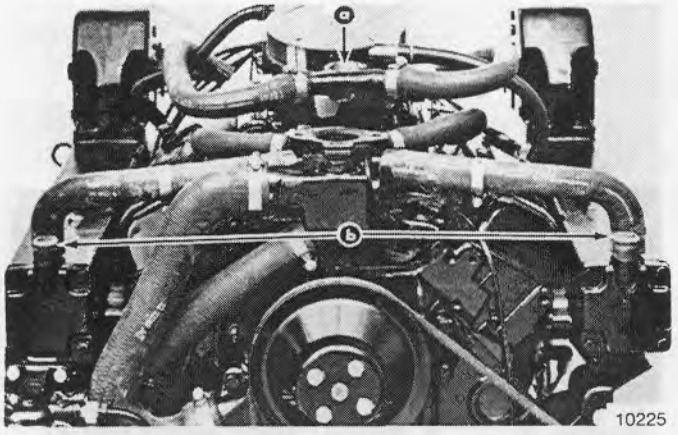
Figure 4. Water Distribution Block (If Equipped)



a - Seawater Pickup Pump
b - Hose - Remove

Figure 5. Seawater Pickup Pump

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcocks and reconnect hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacture for lowest temperature to which engine will be exposed during storage). To fill cooling system, refer to Figure 6.



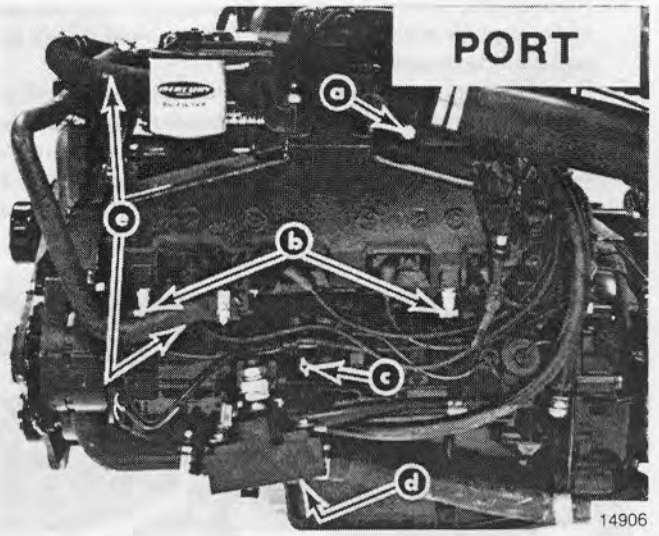
a - Remove Screws, Cover and Thermostat. Fill with Coolant until Block and Heads are Full. Using New Gasket, Install Thermostat and Cover. Torque Screws to Specifications
b - Remove Hoses and Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely

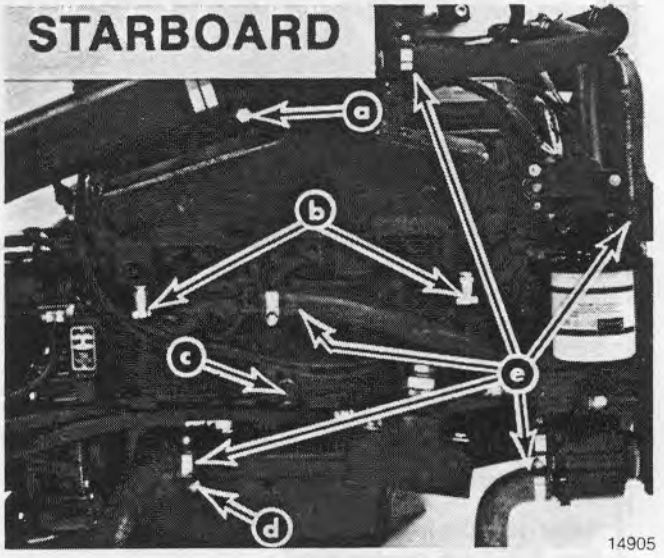
Figure 6. Filling With Coolant

MIE 340

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

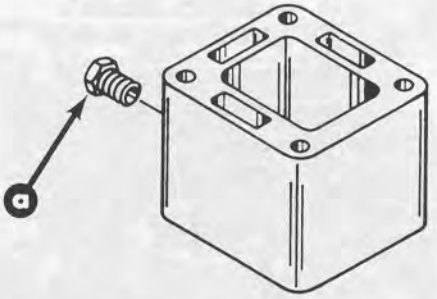
1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figure 1 and 2.





a - Drain Plugs (2) - Remove
b - Petcocks (4) - Remove
c - Petcocks (2) - Remove
d - Remove Drain Plugs (2) or Hoses
e - Hose (7) - Remove, Lower to Drain

Figure 1. Engine Drain Locations



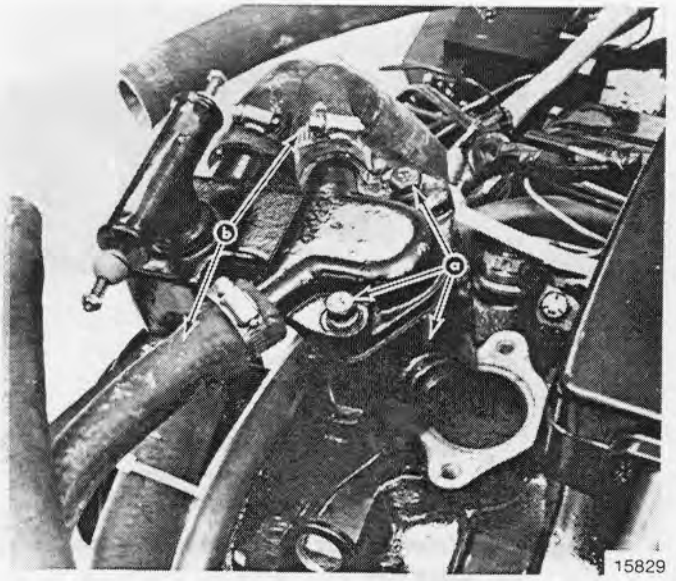
a - Drain Plug - Remove

Figure 2. 3" or 6" Risers (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcocks and reconnect hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacture for lowest temperature to which engine will be exposed during storage). To fill cooling system, refer to Figure 3.

a - Remove Screws and Thermostat Housing. Fill with Coolant until Block and Heads are Full. Using New Gasket, with Continuity Rivets (Do Not Use Perfect Seal), Install Housing. Torque Screws to Specificaitons
b - Remove Hoses and Fill Manifolds with Coolant. Reinstall Hoses and Tighten Calmps Securely

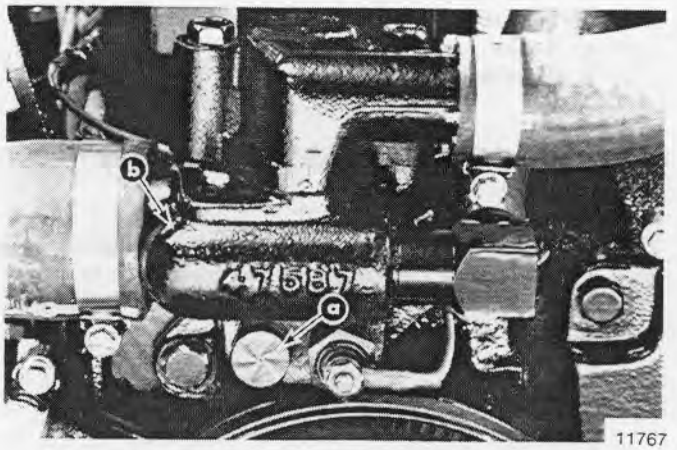
Figure 3. Filling With Coolant



AUXILIARY HOT WATER HEATER INSTALLATION

When connecting a cabin heater or hot water heater to a MerCruiser Engine, certain requirements must be met.

- Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8" (16mm) I.D. (Inside Diameter).
- **MerCruiser Engines Equipped With a Closed Cooling System:** Heater MUST BE LOWER than the fill cap on the heat exchanger. If the heater is higher than the fill cap on the heat exchanger and some coolant is lost in the system, an air pocket may form in the closed cooling system. This in turn, can cause the engine to overheat.
- Make heater connections to MerCruiser engines only at locations shown.
- Check complete system for leaks after heater is connected into cooling system.
- Check for overheating condition (of engine) after heater is connected into cooling system.



a - Plug - See Important
b - Thermostat Housing

Figure 1. Water Heater Supply Connection Location

MCM 120/140/165

An Auxiliary Hot Water Heater Kit is not available from Mercury Marine, for the above model MerCruiser engines. To connect a cabin heater or hot water heater to these engines, use the following procedure.

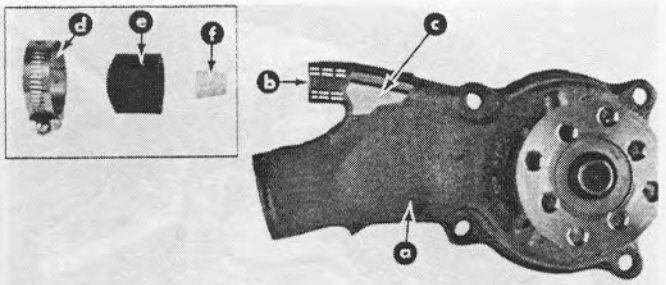
1. Drain water from cooling system.
2. Remove plug from thermostat housing at location shown in Figure 1.

IMPORTANT: If thermostat housing is equipped with a 1/8" .27 NPT plug (same size as exhaust manifold drain plug), hole from which pipe plug was removed must be rethreaded to 3/8 - 18 NPT. To rethread hole, remove thermostat housing and drill out hole to 37/64" then rethread using a 3/8" - 18 NPT tap. Blow out housing with compressed air to remove metal chips and reinstall housing with a new gasket. Torque bolts to 30 lbs. ft. (41 N.m). Hole in newer style thermostat housing is threaded to 3/8" - 18 NPT and requires no modification.

3. Coat threads of an appropriate size bayonet type fitting (obtained from a local source) with Perfect Seal and install into threaded hole. Tighten fitting securely.
4. Connect hot water heater supply hose to bayonet fitting and secure with a hose clamp.
5. Drill 3/8" (10mm) hole into circulating pump on front of engine. (Figure 2)

IMPORTANT: By using grease on drill bit and being careful during drilling, most metal chips can be caught in grease. If this cannot be done, remove circulating pump for drilling. Clean pump thoroughly with compressed air, reinstall using new gasket.

a. On some earlier model engines, a wooden plug and rubber cap or just a rubber cap is installed on circulating pump. Remove clamp and discard these pieces. (Figure 2)



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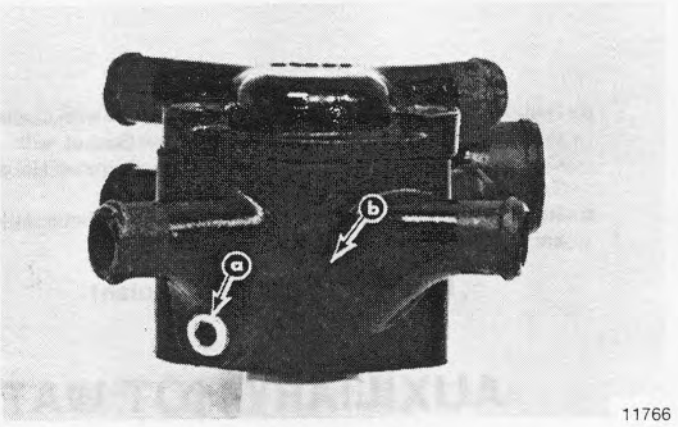
a - Circulating Pump
b - Drill 3/8" (10mm) As Shown
c - Water Chamber
d - Hose Clamp (Some Models)
e - Rubber Clamp (Some Models)
f - Wooden Plug (Some Models)

Figure 2. Water Heater Return Hose Connection Location

6. Connect hot water heater return hose to fitting on circulating pump and secure with hose clamps.
7. Support hoses, as required, to ensure that they do not rub or chafe against engine components.
8. With boat in the water, start engine and check for:
   a. Leaks
   b. Overheating

MCM/MIE V-8 ENGINES (74567A1 KIT)

1. Drain cooling system.
2. Remove thermostat housing assembly from intake manifold. DO NOT remove cover from thermostat housing.
3. Remove ⅜" NPT plug from aft port side of thermostat housing. (Figure 3)
4. Install the appropriate type fitting(s) (obtain from local source) in threaded hole from which pipe plug was removed to allow connection of water heater suply hose. Coat threads of fittings(s) with Perfect Seal before installing.
5. Reinstall thermostat housing using new gasket. Torque bolts to specifications.
6. Connect hot water heat supply hose to fitting and secure with a clamp (not provided).



11766

a - 3/8" NPT Plug
b - Thermostat Housing

Figure 3. Water Heater Supply Hose Connection

7. Connect auxiliary hot water heater return hose into cooling system with "T" fitting and hose clamps as shown in Figures 4, 5, 6 or 7. Cut approximately ¾" (19mm) out of hose to maintain proper hose configuration.
8. Tighten "T" fitting hose clamps securely.
9. Support hoses, as required, to ensure that they do not rub or chafe against engine components.
10. With boat in the water, start engine and check for:
    a. Leaks
    b Overheating

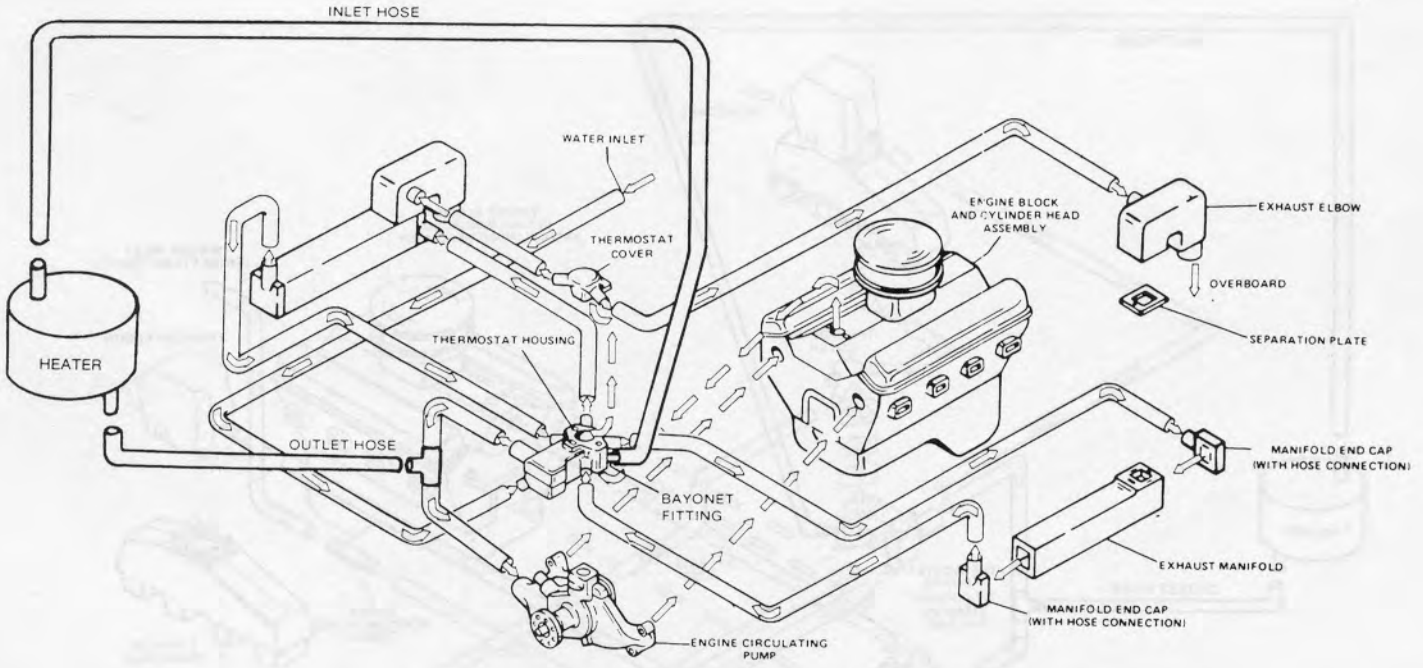


Figure 4. Heater Connection on Typical MerCruiser V-8 (GM) Engine with Standard Cooling

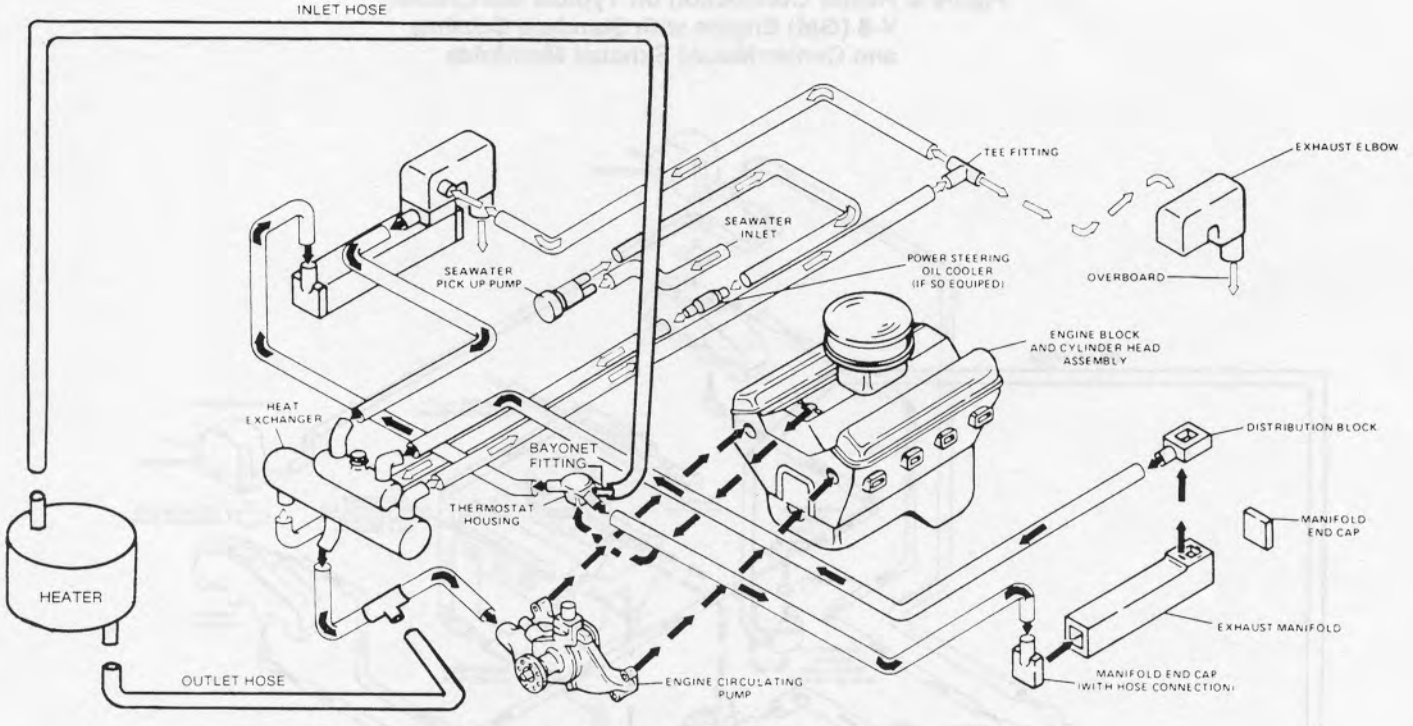


Figure 5. Heater Connection on Typical MerCruiser V-8 (GM) Engine Equipped with a Closed Cooling System

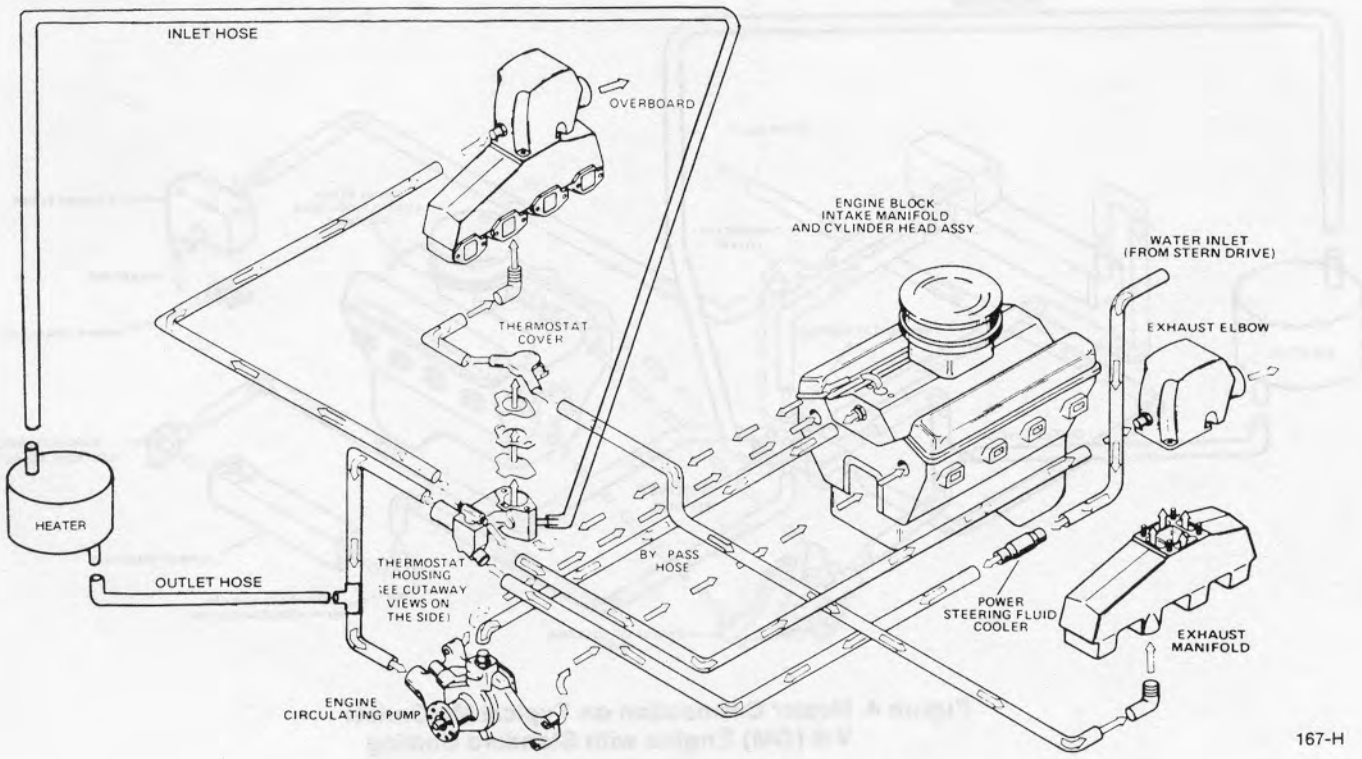


Figure 6. Heater Connection on Typical MerCruiser V-8 (GM) Engine with Standard Cooling and Center Mount Exhaust Manifolds

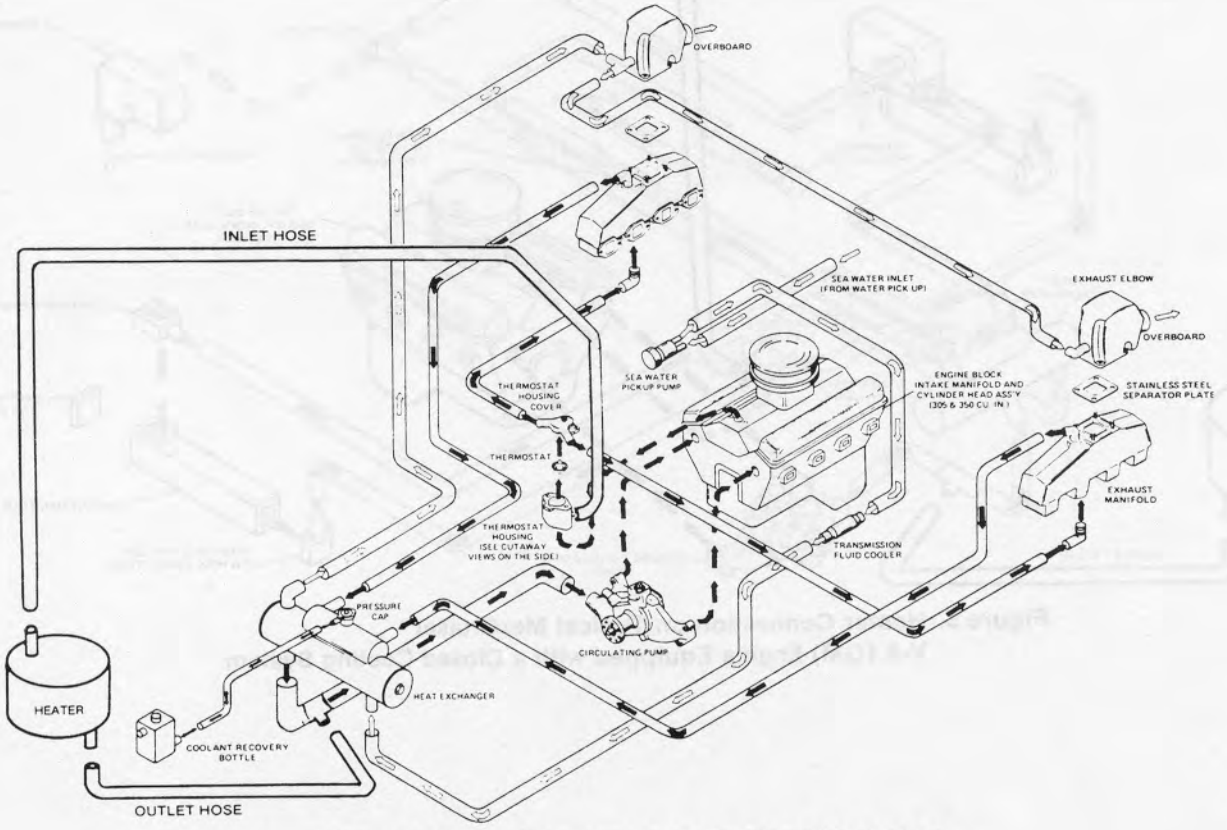


Figure 7. Heater Connection on Typical MerCruiser V-8 (GM) Engine with Center Mount Exhaust Manifolds and Equipped with a Closed Cooling System

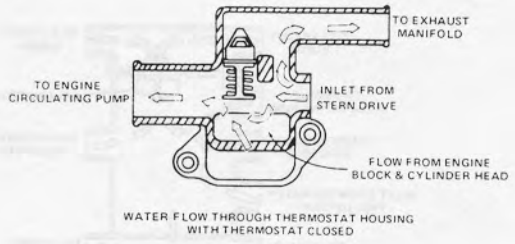
COOLING SYSTEM FLOW DIAGRAMS

MerCruiser engines with standard cooling systems use seawater (water in which the boat is being operated) to remove the heat given off by the engine.

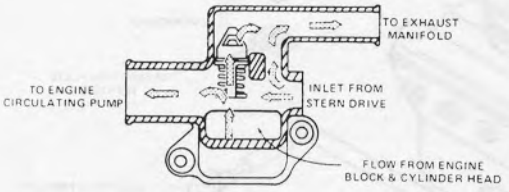
The seawater is pumped to the cooling system by means of an impeller type pickup pump (located in the vertical drive or belt driven at the front of engine) which picks up seawater and delivers it to the centrifugal pump (located over an opening on the front of the cylinder block). On some models, seawater may be pumped through an oil cooler before going to the circulating pump. The centrifugal pump then circulates the seawater through the block, head(s) and manifold(s), removing the heat given off by these parts as it passes.

After passing through the engine, the seawater is pumped into the exhaust elbow, where it mixes with the exhaust gases, and is expelled overboard.

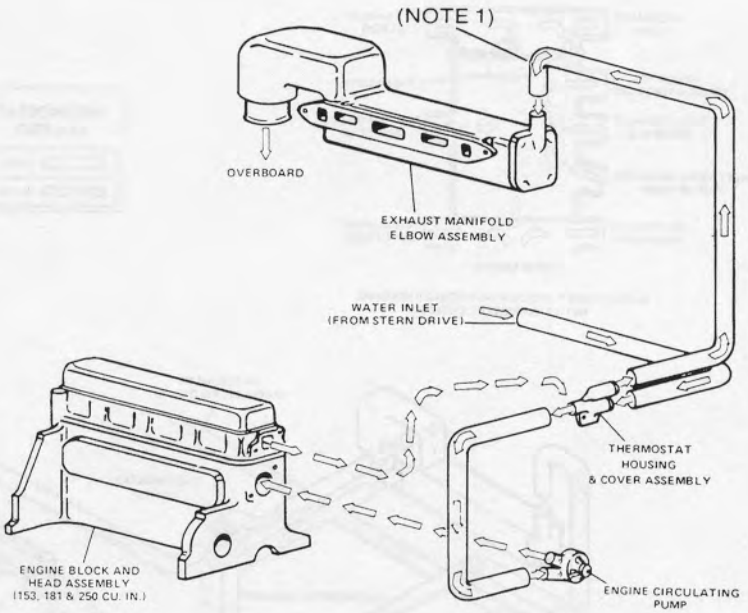
A thermostatic heat control, which controls circulation of the seawater, also is incorportated into the system. It provides fast engine warmup and controlled operating temperature.



WATER FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

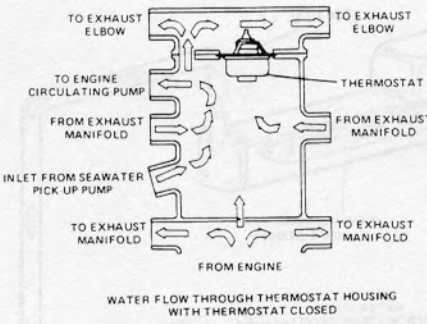


WATER FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

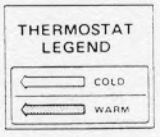


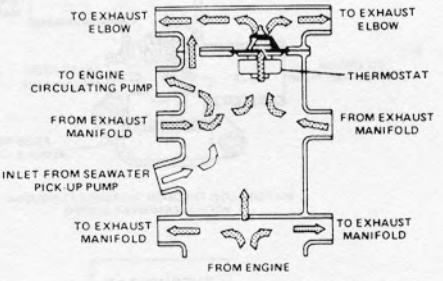
NOTE 1: Some MCM 165 models may have a reversed manifold water flow kit installed. On those models, this hose is connected to the rear end cap. Water then flows forward (in the manifold) to the front end cap, then, via a hose, to the exhaust elbow and overboard. Gaskets and a stainless steel separator plate prevent water from flowing between the manifold and exhaust elbow.

MCM 120/140/165

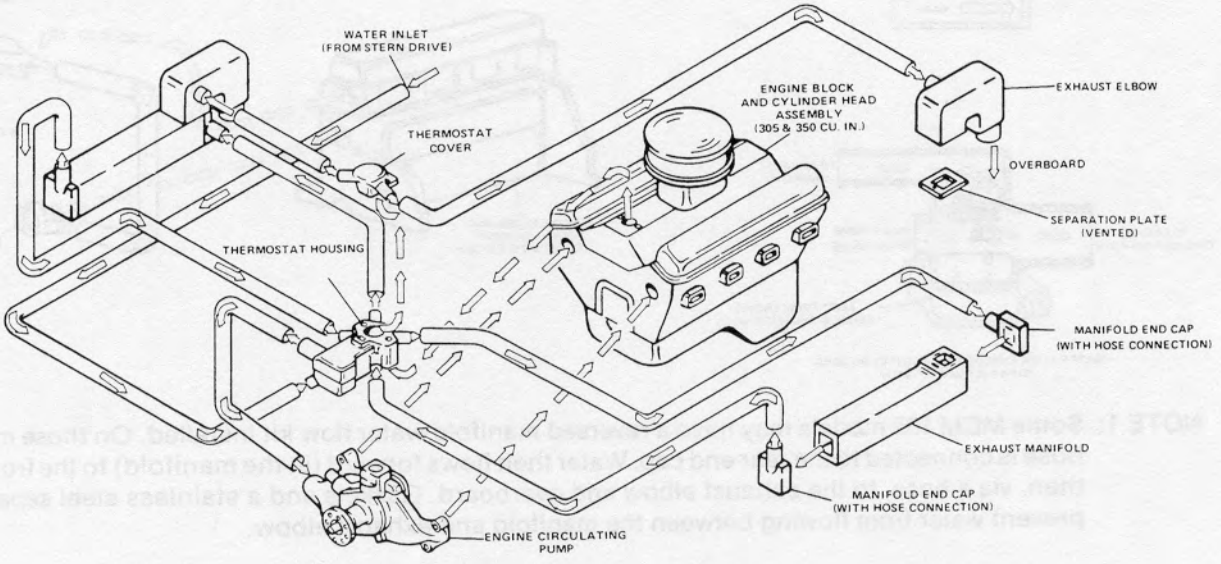


WATER FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

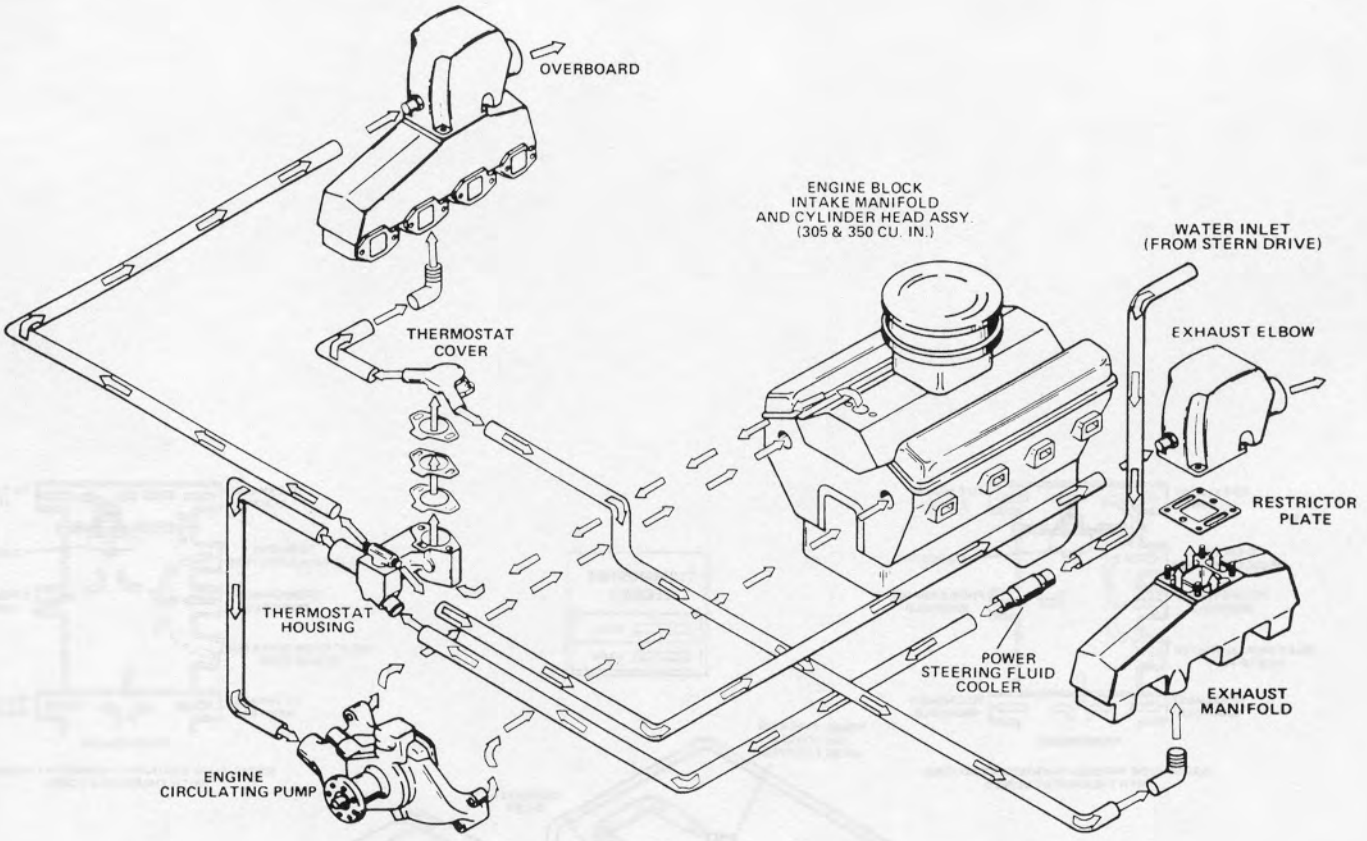


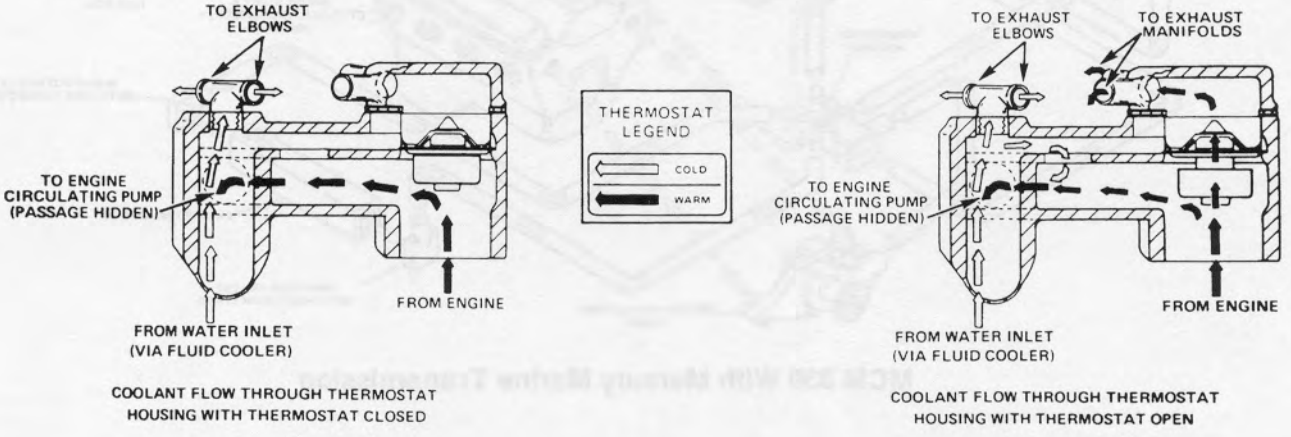


WATER FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN



MCM 898/228/260





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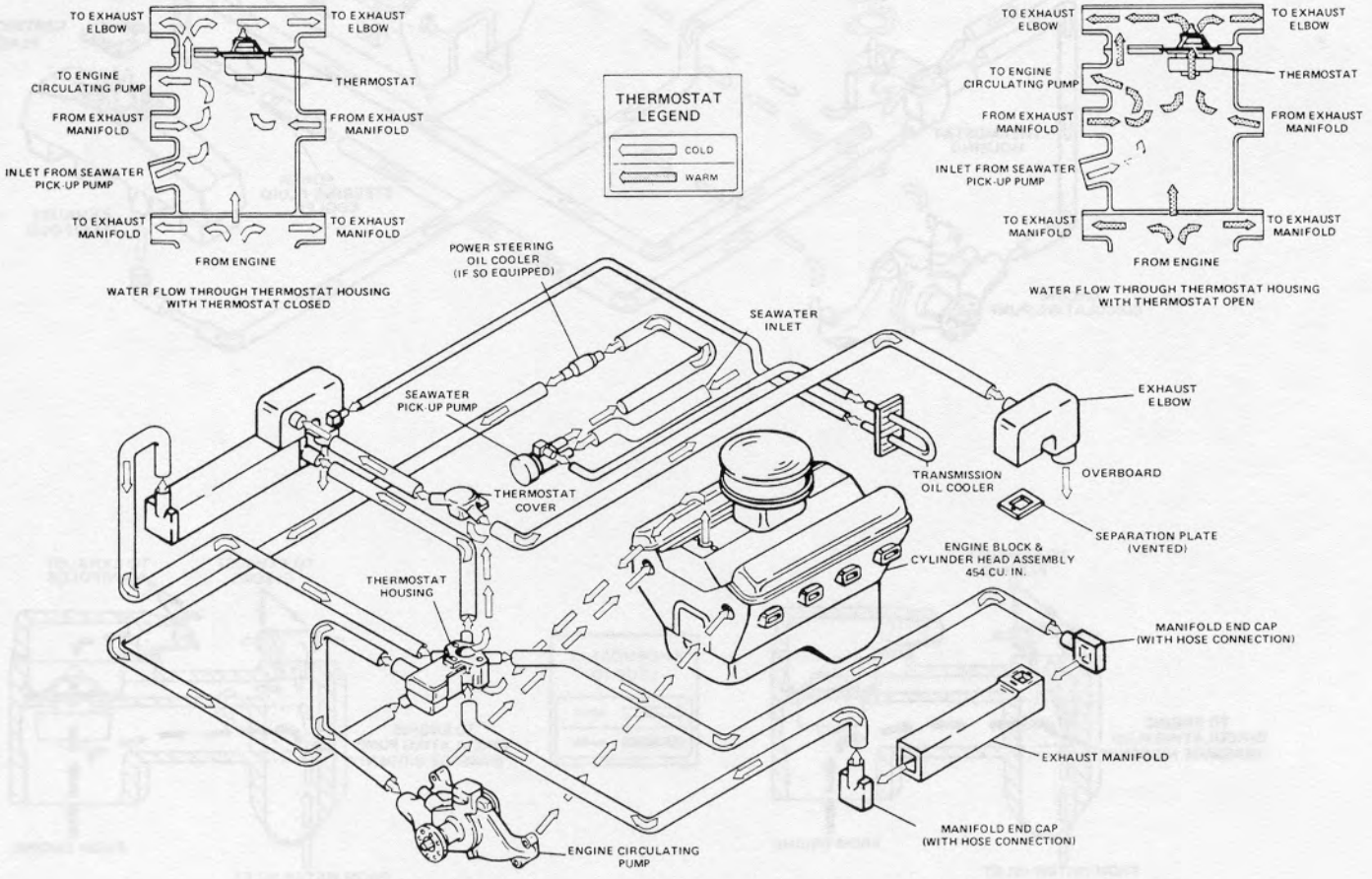
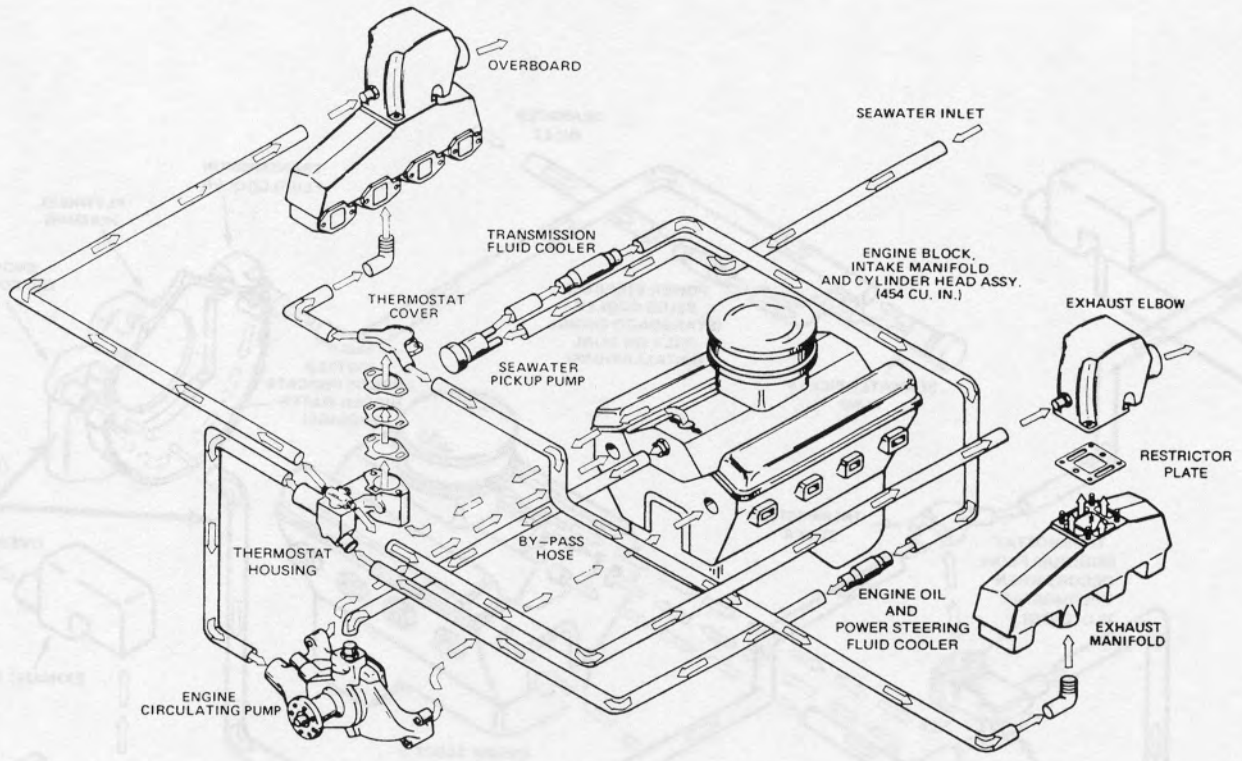
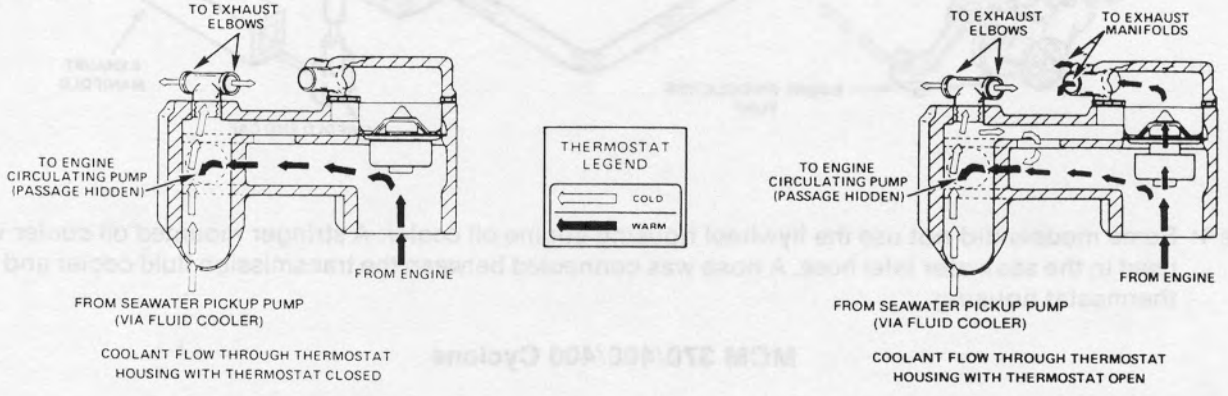
MCM 898R/228R/260R

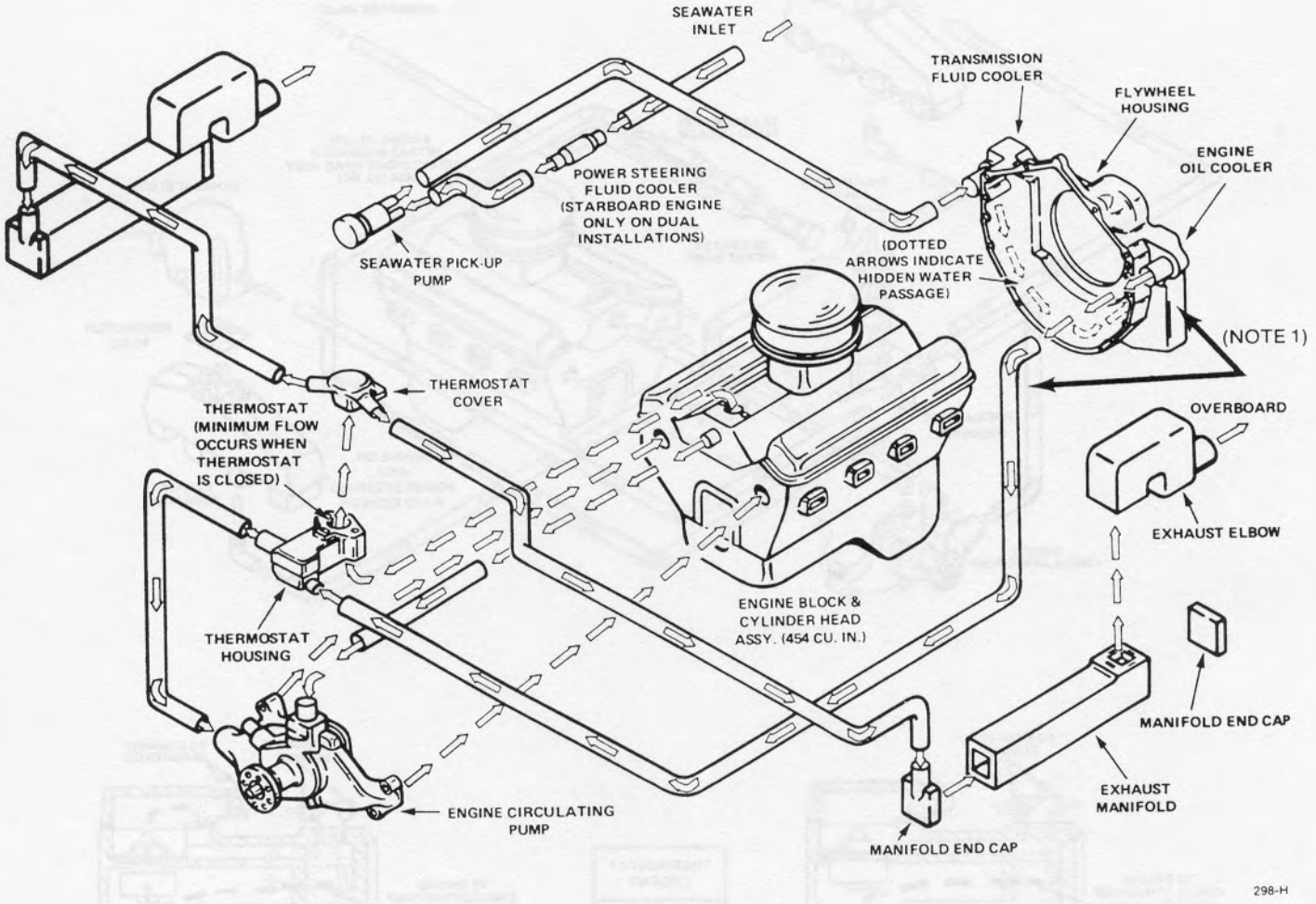


MCM 330 With Mercury Marine Transmission


OVERBOARD
SEAWATER INLET
TRANSMISSION FLUID COOLER
ENGINE BLOCK, INTAKE MANIFOLD AND CYLINDER HEAD ASSY. (454 CU. IN.)
THERMOSTAT COVER
EXHAUST ELBOW
SEAWATER PICKUP PUMP
RESTRICTOR PLATE
THERMOSTAT HOUSING
BY-PASS HOSE
ENGINE OIL AND POWER STEERING FLUID COOLER
EXHAUST MANIFOLD
ENGINE CIRCULATING PUMP

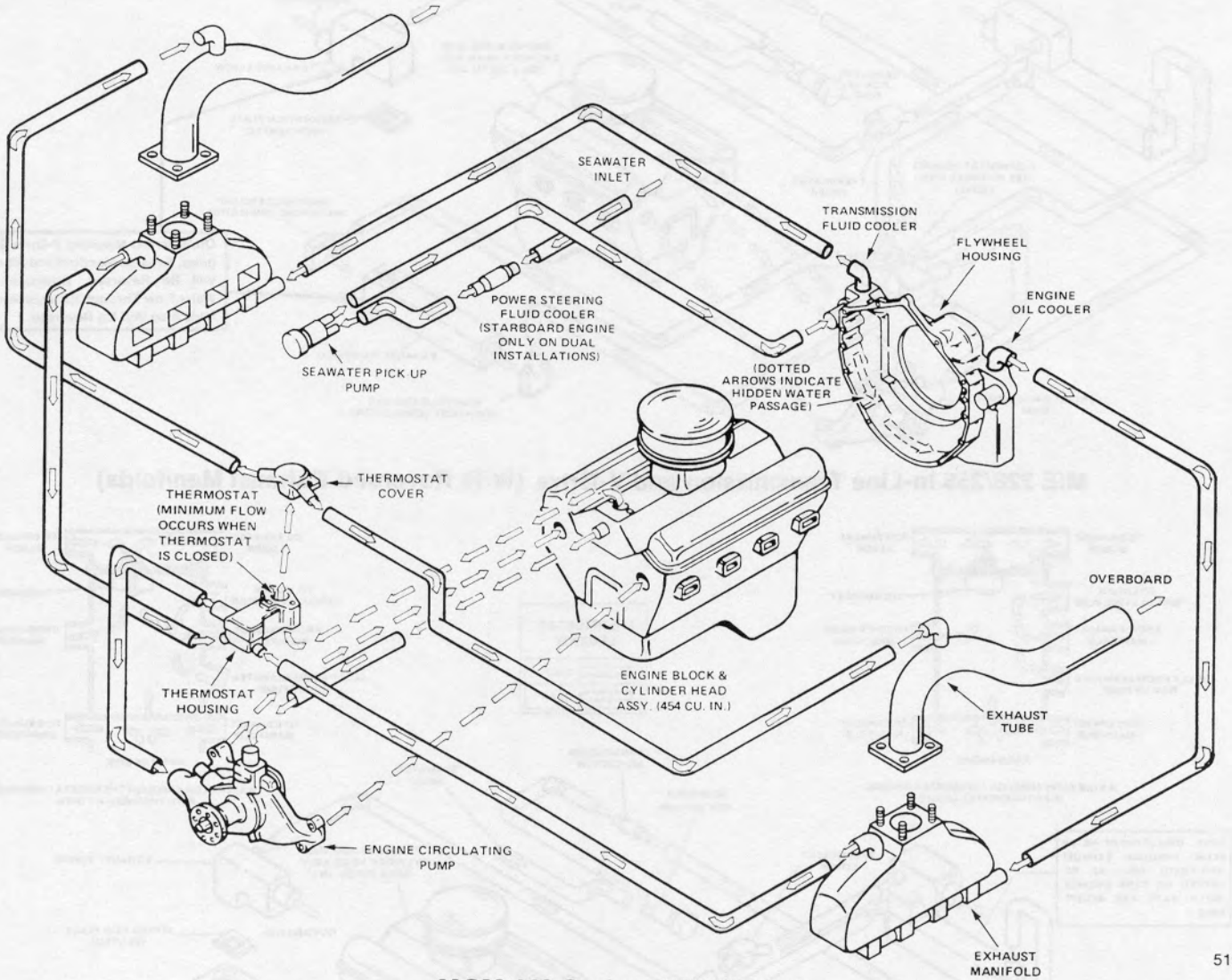

TO EXHAUST ELBOWS
TO ENGINE CIRCULATING PUMP (PASSAGE HIDDEN)
FROM ENGINE
FROM SEAWATER PICKUP PUMP (VIA FLUID COOLER)
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED
THERMOSTAT LEGEND
COLD
WARM
TO EXHAUST ELBOWS
TO EXHAUST MANIFOLDS
TO ENGINE CIRCULATING PUMP (PASSAGE HIDDEN)
FROM ENGINE
FROM SEAWATER PICKUP PUMP (VIA FLUID COOLER)
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

MCM 330 (B-W)



Note 1: Some models did not use the flywheel housing engine oil cooler. A stringer mounted oil cooler was used in the seawater inlet hose. A hose was connected between the transmission fluid cooler and the thermostat housing.

MCM 370/400/400 Cyclone



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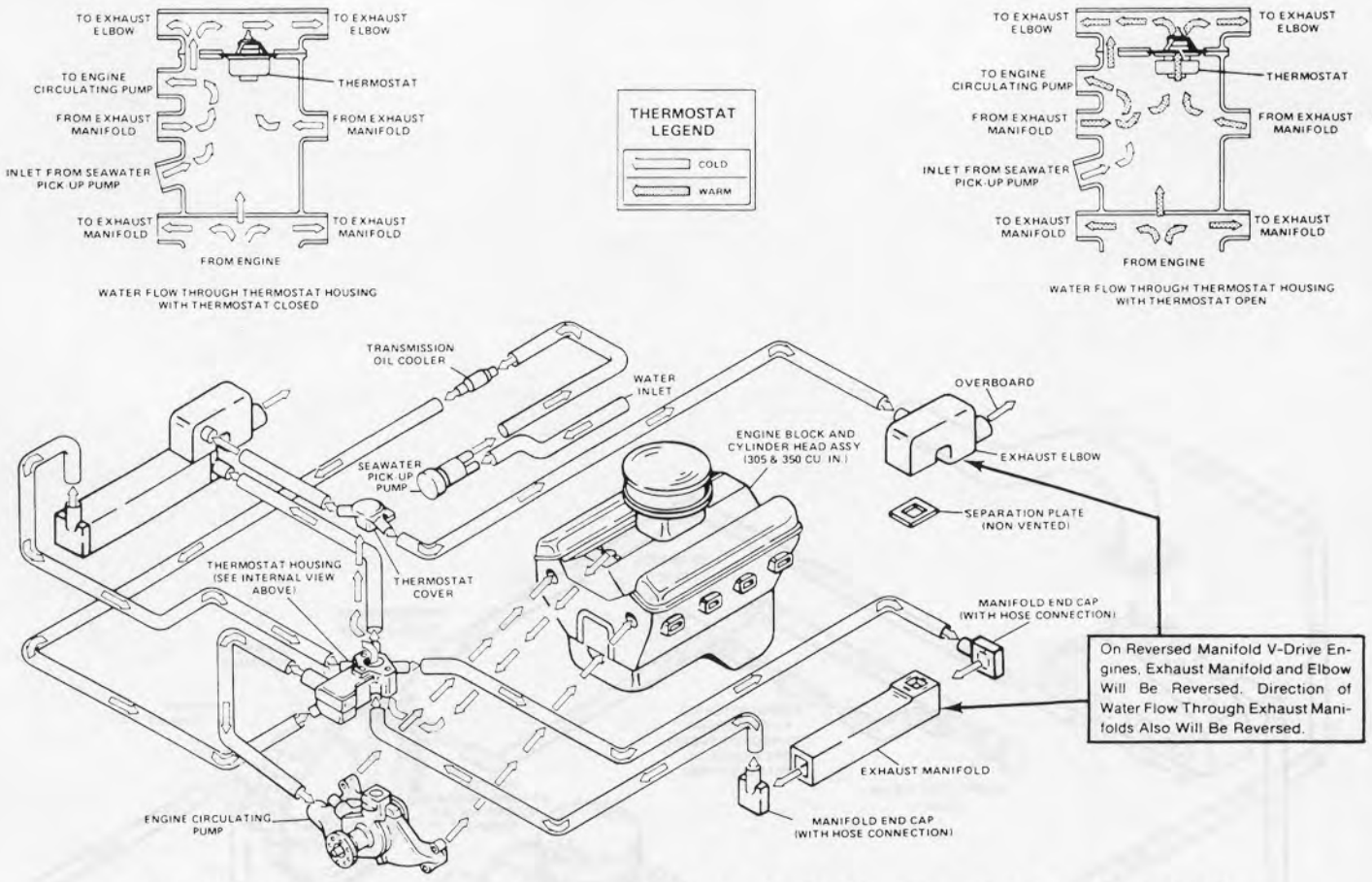
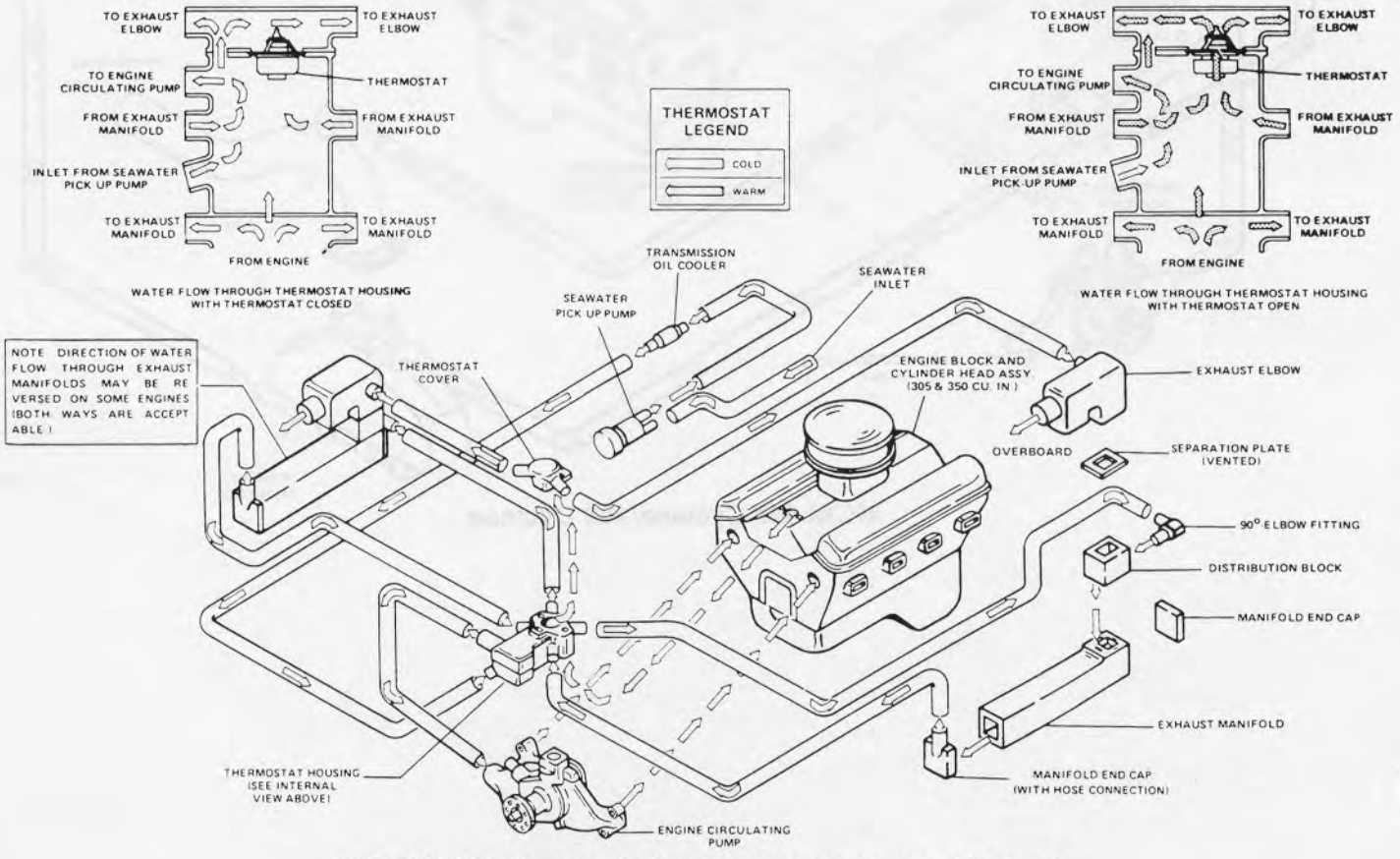
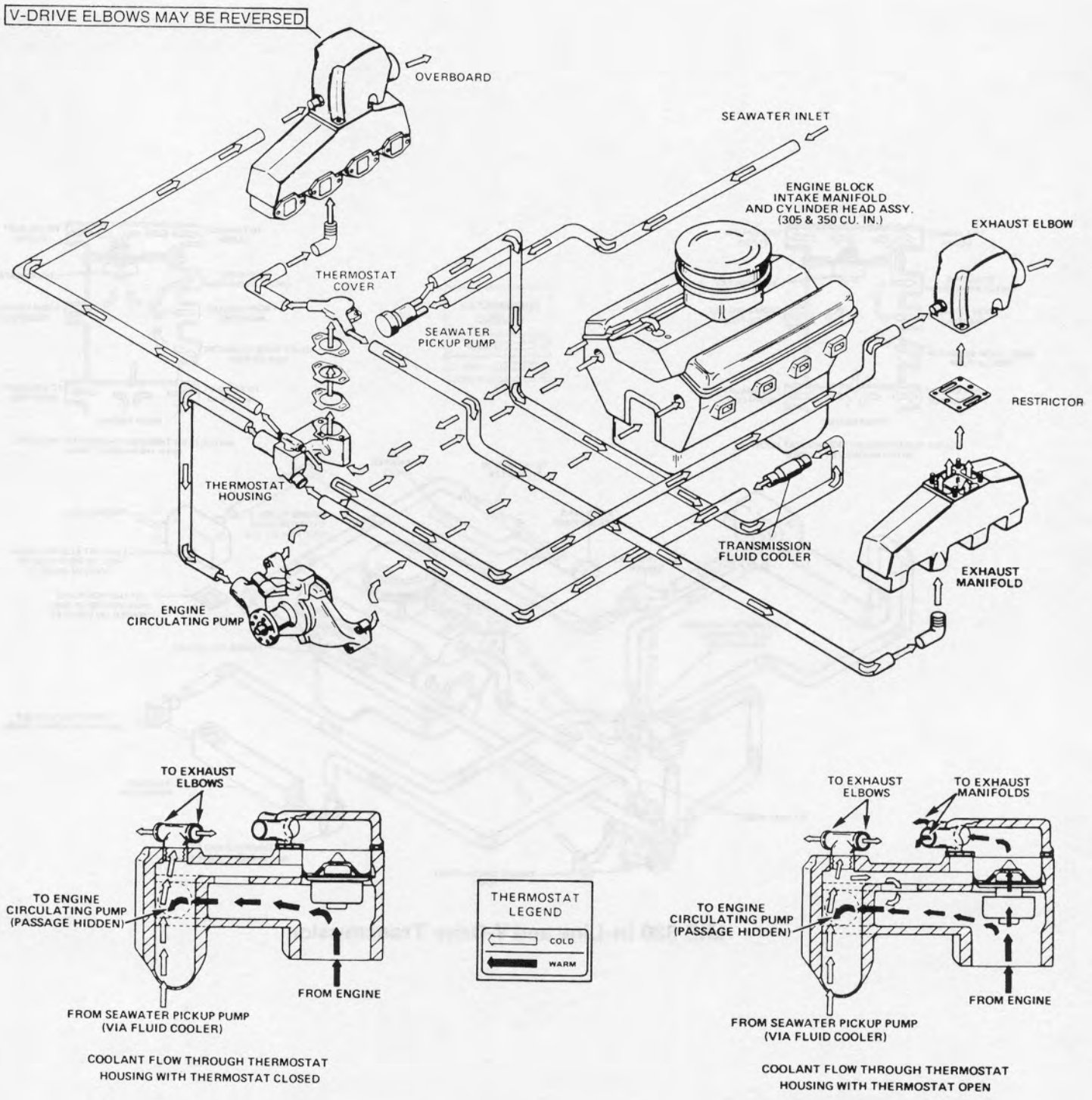
MCM 440 Cyclone/460 Cyclone



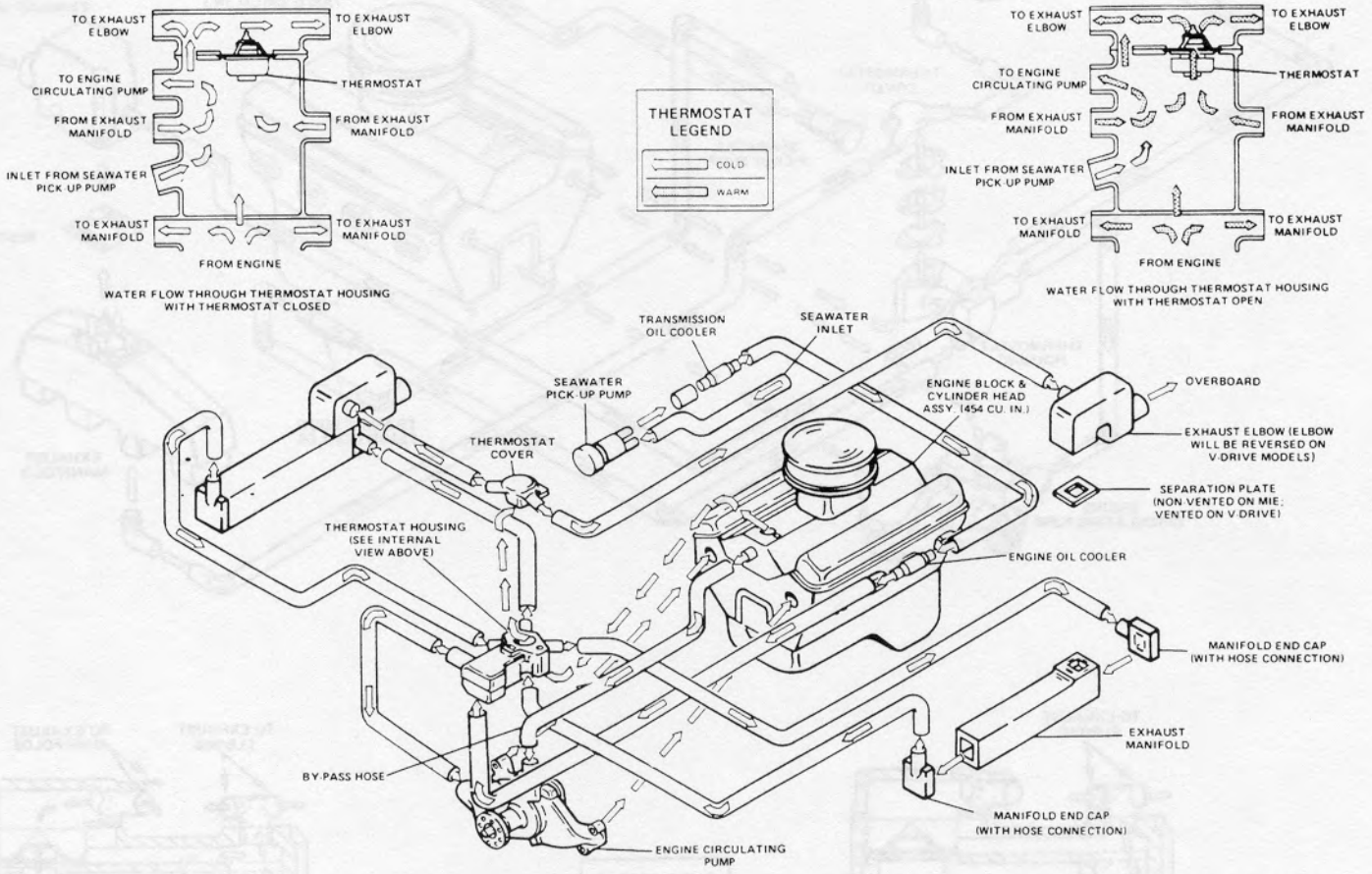
MIE 228/255 In-Line Transmission and V-Drive (With Reversed Exhaust Manifolds)



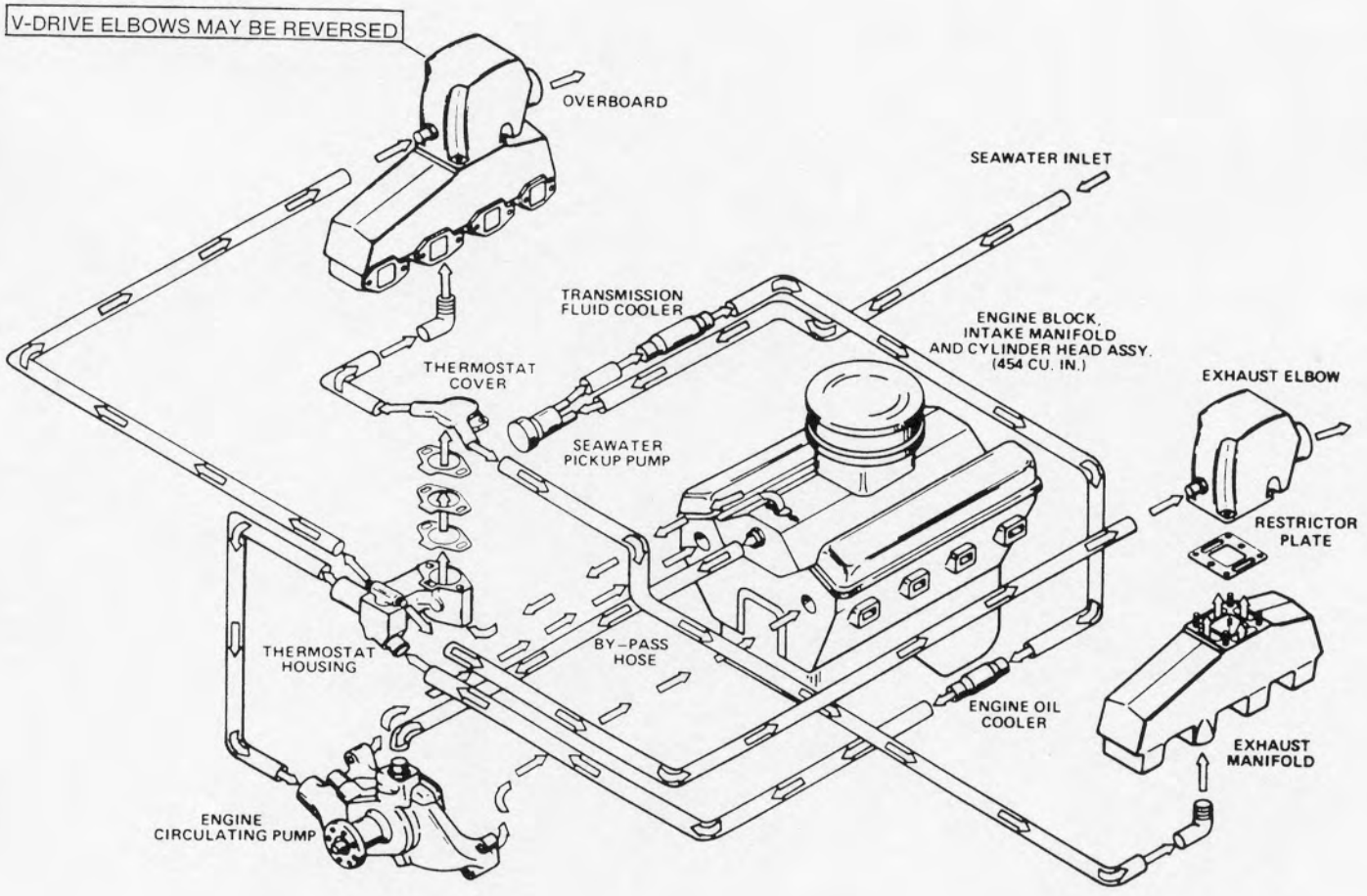
MIE 228/255 V-Drive (With Reversed Exhaust Elbows)

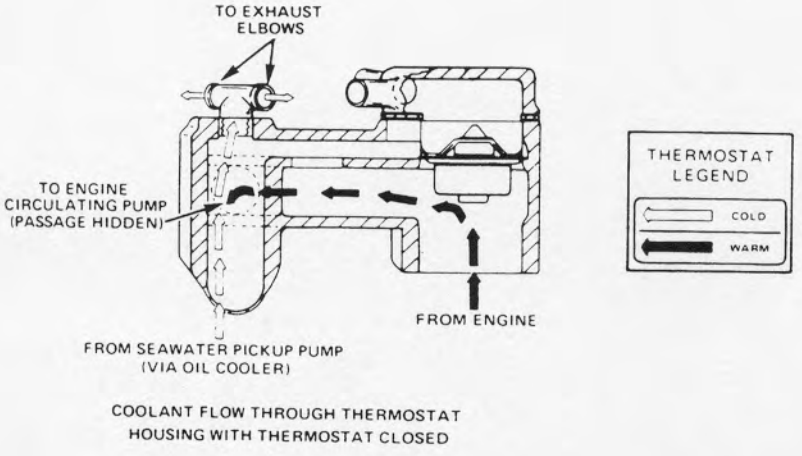


MIE 230/260 In-Line and V-Drive Transmission



MIE-330 In-Line and V-Drive Transmission





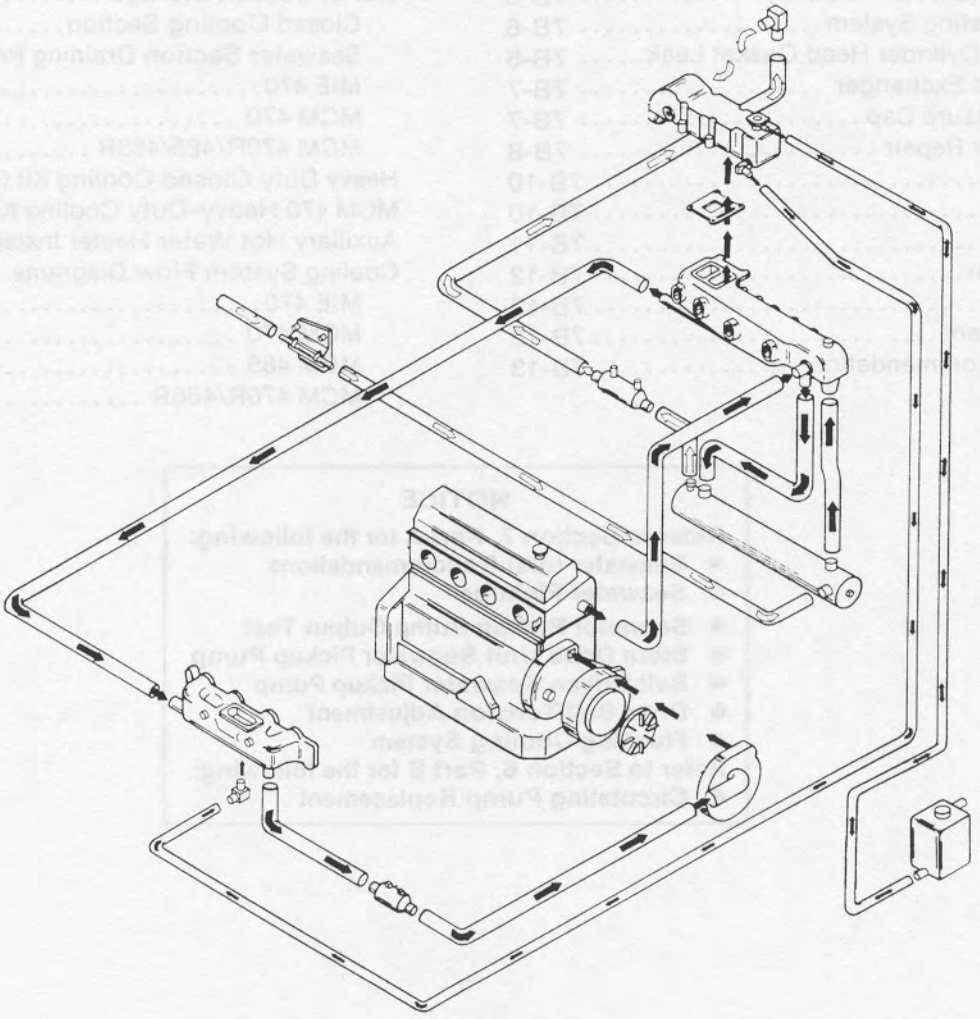
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

MIE 340 In-Line and V-Drive Transmission

SECTION 7 - COOLING SYSTEM

PART B - 470/485/488



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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NOTICE

Refer to Section 7, Part A for the following:

- **Seawater Inlet Recommendations**
- **Seawater Pickups**
- **Seawater Pickup Pump Output Test**
- **Stern Drive Unit Seawater Pickup Pump**
- **Belt Driven Seawater Pickup Pump**
- **Drive Belt Tension Adjustment**
- **Flushing Cooling System**

Refer to Section 6, Part B for the following:

- **Circulating Pump Replacement**

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
4" (102mm) Dia. Heat Exchange End Cap		120-140 (13.6-15.8)
3" (76mm) Dia. Heat Exchanger End Caps		24-60 (2.7-6.7)
Hose Clamps	Securely	
Reservoir (470)	20 (27)	
Exhaust Elbow/Reservoir (470R/485/488R)	30 (41)	
Thermostat Housing (470)	20 (27)	
Thermostat Housing (470R/485/488R)	20 (27)	
Heat Exchanger Mounting Brackets	Securely	
Drain Plugs	Securely	

LUBRICANTS/SEALANTS

LUBRICANTS/SEALANTS	
92-86154A1	Quicksilver 2-4-C Multi-Lube
92-34227-1	Quicksilver Perfect Seal

SPECIFICATIONS

CLOSED COOLING SYSTEM CAPACITY	
Model	**Qts (Litres) Approximately**
MIE 470	10-1/2 (9.9)
MCM 470 3" (76mm) Dia. Heat Exchanger	10-1/2 (9.9)
MCM 470R 4" (102mm) Dia. Heat Exchanger	11 (10.4)
MCM 485 3" (76 mm) Dia. Heat Exchanger	10-1/2 (9.9)
MCM 488R 4" (102mm) Dia. Heat Exchanger	11 (10.4)

THERMOSTAT	
All Models	160° F (71° C)

PRESSURE CAP	
All Models	14 PSI (97 KPa)

DESCRIPTION

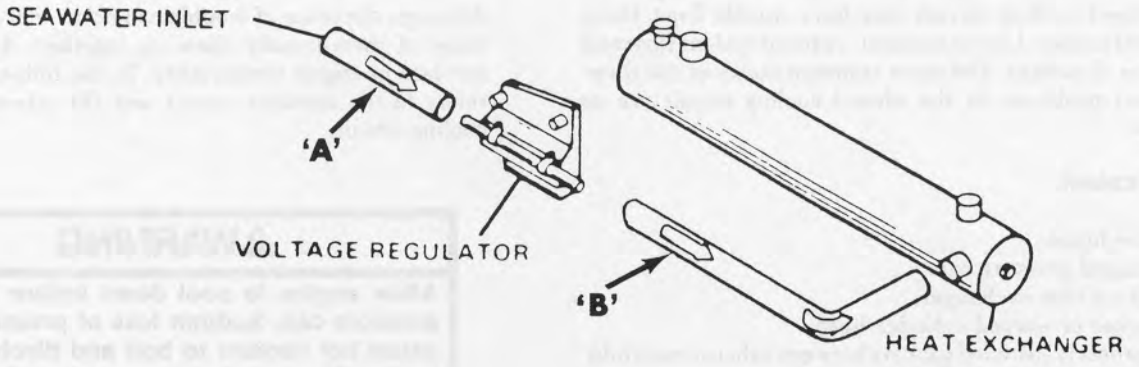
There are several configurations of this cooling system, but the operation is essentially identical. Basically, the system is composed of two separate sub-systems; the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile. The closed cooling system is similar in function to the rest of the cooling system in an automobile with the heat exchanger functioning as the radiator. The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately ½ pint during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there's a vacuum leak, usually at the hose leaving the reservoir, or the gasket under the recovery filler cap. The gasket seals against the outer rim of the filler neck. The air bleed system is designed to reduce or remove aeration which occurs during filling, or slight head gasket leakage. The system operates by producing a small flow through the reservoir which allows coolant/air bubbles to separate and vent the air bubbles off while passing through the reservoir. For the system to operate properly, the small hose and fittings going from the reservoir to the exhaust (or intake manifold) must not be plugged.

REGULATOR HOSE REPLACEMENT INFORMATION

Voltage regulators 86255A2 and A3 had a ⅝" dia. water tube. These two regulators supersede to 99502A8. The 99502A8 regulator has a ¾" dia. regulator to the ⅝" dia. heat exchanger and gimbal housing water inlet tube. Chart shows the replacement hose part numbers for the various heat exchanger/regulator/water inlet tube combinations.

HOSE 'A'		
Water Inlet Tube O.D.	**Regulator Tube O.D.**	**Hose Part Number**
5/8" (16mm)	5/8" (16mm)	32-47642
5/8" (16mm)	3/4" (19mm)	32-99519

HOSE 'B'		
Regulator Tube O.D.	**Heat Exchanger Tube O.D.**	**Hose Part Number**
5/8 " (16mm)	5/8" (16mm)	32-88132
5/8" (16mm)	3/4" (19mm)	32-41497
3/4" (19mm)	5/8" 16 (16mm)	32-99521
3/4" (19mm)	3/4" (19mm)	32-99520



MAINTAINING COOLANT LEVEL

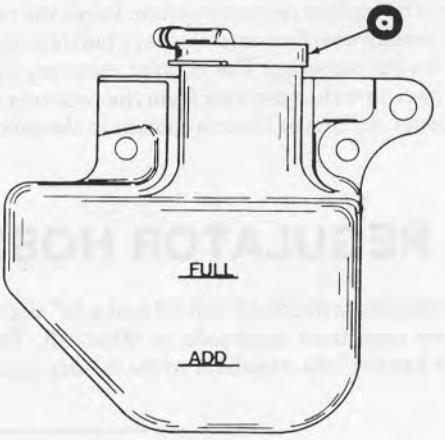
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then push down and turn cap all-the-way off.

1. Coolant level in heat exchanger should be within 1″ (25 mm) from bottom of filler neck.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on filler neck.

2. Coolant level should be between the "Add" and "Full" mark on coolant recovery reservoir with engine at normal operating temperature. (Figure 1)



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a - Fill Cap

Figure 1. Coolant Recovery Bottle

TROUBLESHOOTING THE COOLING SYSTEM

The following is a general guide to troubleshoot the closed cooling system used on MerCruiser 4 Cylinder 224 CID Engines (470/485/488).

1. The seawater circuit has one prime cause of trouble: reduced water flow (similar to reduced air flow in an automobile). The most common causes of reduced seawater flow:
   a. Bad seawater pump impeller.
   b. Kinked or loose hoses.
   c. Impeller blade or debris in drive/transom assembly water passages.
   d. Blockage in heat exchanger (seawater circuit).
   e. Blocked exhaust elbow.
   f. Improperly repaired heat exchanger.
   g. Hose fitting in exhaust elbow installed too deep.
2. The closed cooling circuit can have trouble from three different causes: Loss of coolant, reduced coolant flow and aeration of coolant. The most common causes of the three different problems in the closed cooling circuit are as follows:

Loss of Coolant

a. Loose hoses.
b. Damaged pressure cap.
c. Leaking heat exchanger.
d. Cracked or warped cylinder head.
e. Improperly installed gaskets between exhaust manifold and exhaust elbow.
f. Cracked manifold.
g. Worn seals on circulating pump.
h. Cylinder block porosity.

Reduced Flow

a. Thermostat failure or automotive thermostat being used.
b. Aeration.
c. Blockage in heat exchanger (closed cooling circuit).
d. Loose circulating pump impeller.
e. Collapsing hoses.

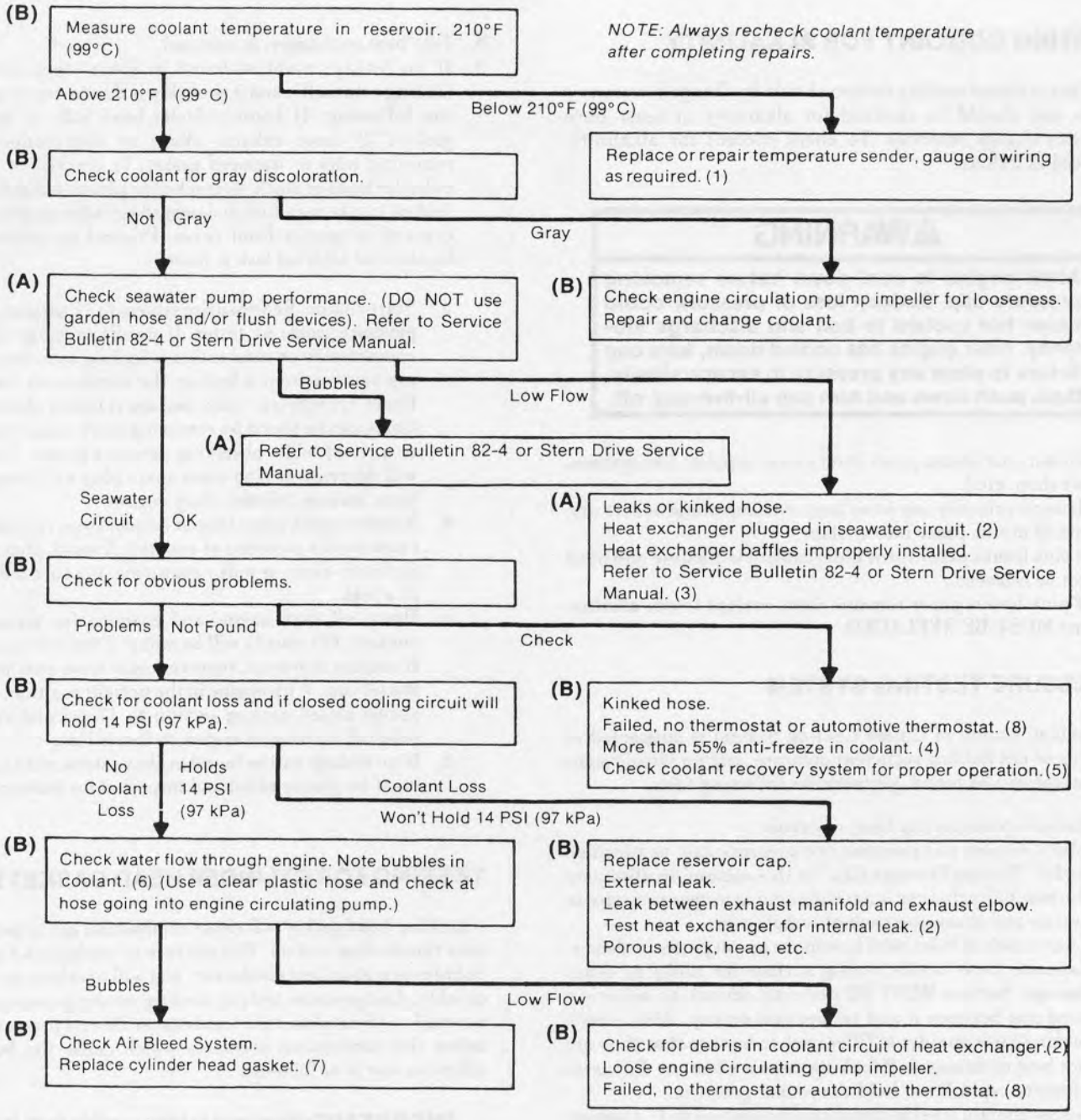
Aeration

a. Improper filling.
b. Leaking cylinder head gasket.

Although the cause of trouble can occur individually, two or three of them usually show up together. All result in an increase in engine temperature. In the following Chart, (A) refers to the seawater circuit and (B) refers to the closed cooling circuit.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.



Note 1: Normal operating engine temperature taken at the water temperature sender with a direct reading gauge is 165° F (74° C) to 200° F 93° C) at W.O.T. Dual station boats must use a dual station water temperature sender.

Note 2: Refer to "Testing" Heat Exchanger.

Note 3: MIE seawater pump flows 30-32 Gal/Min. at 4200 RPM.

Note 4: % of anti-reeze in coolant can be checked with anti-freeze tester.

Note 5: Refer to "Coolant Recovery and Air Bleed Systems Operation".

NOTE 6: Run in lake for this test.
Note coolant color in clear plastic hose and reservoir before starting engine. Coolant is dark in color. Start engine and run at 3500 RPM.
Normal: *Coolant is dark in color (near the color before starting engine) with some air bubbles.*
Abnormal: *Coolant becomes very light in color because of many bubbles.*

NOTE 7: Refer to "Testing for Cylinder Head Gasket Leak".

NOTE 8: Automotive thermostats CANNOT BE USED in these engines because they DO NOT direct the coolant flow to the heat exchanger when thermostat is open.

TESTING SYSTEM

TESTING COOLANT FOR ALKALINITY

Coolant in closed cooling section should be changed every two years and should be checked for alkalinity at least once between change intervals. To check coolant for alkalinity, proceed as follows:

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. If pink litmus paper turns blue, coolant is alkaline and need not be replaced.
4. If pink litmus paper remains pink, coolant is not alkaline and MUST BE REPLACED.

PRESSURE TESTING SYSTEM

If coolant section of Closed Cooling System is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined under "Testing Pressure Cap" in this section, to eliminate the possibility that cap is not maintaining proper pressure in system and is causing coolant to boil over.
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for nicks or other damage. Surface MUST BE perfectly smooth to achieve a good seal between it and rubber seal on cap. Also, check locking cams on sides of filler neck to be sure that they are not bent or damaged. If locking cams are bent or damaged, pressure cap will not hold the proper pressure.
4. Adjust coolant level in closed cooling section to 1" (25mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to 17 psi (117 kPa).
6. Observe gauge reading for approximately 2 minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining a pressure of 17 psi on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, core plugs, etc.) for leakage. Also listen closely for bubbling or hissing, as they usually are a sure indication of a leak.
8. Test heat exchanger, as outlined.
9. If no leakage could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following: 1) Loose cylinder head bolts or damaged gasket, 2) loose exhaust elbow or distribution block retaining nuts or damaged gasket, 3) cracked or porous cylinder head or block, 4) cracked or porous exhaust manifold or intake manifold 5) damaged circulating pump seals cracked or porous front cover. Proceed as follows until location of internal leak is found —

   a. Start engine. Repressurize system to 17 psi and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinder(s), where leakage is taking place, sometimes can be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when spark plug wire is removed from leaking cylinder. Stop engine.
   b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug, that is perfectly clean or milky appearing, is a sure indication of a leak.
   c. Drain oil from engine and examine for presence of coolant. Oil usually will be milky, if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, repressurize closed cooling section to 17 psi and examine internal surfaces of engine to locate leak.
   d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

TESTING FOR CYLINDER HEAD GASKET LEAK

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor; and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures which cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (61-91cm) long hose for this test.
2. Route this hose so a "U" is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (10-13cm) of the "U".
4. Observe the "U" while the engine is running.
   a. During idle and warm-up: some coolant and/or air will leave the reservoir.

b. During cruising speed (2500-3500 RPM): coolant and/or air leaving the reservoir should stop after approximately 5 minutes running at a given RPM. A leaking head gasket will produce air bubbling through the "U", going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.

c. At higher speeds (4000+RPM): Normal operation is the same as described in "b" above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant leaving the reservoir.

It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately 5 minutes at a given RPM. A head gasket leak will not stop - the one thing that marks a failed head gasket is the continued passage of air, that may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant continues to flow (not in violent, intermittent bursts) from the reservoir at cruising speed, something else besides the head gasket is causing the engine to overheat.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

TESTING HEAT EXCHANGER

For Internal Leak: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

a. Remove a seawater hose from the exchanger. DO NOT DRAIN the exchanger.
b. Pressurize the closed cooling circuit to 14-20 PSI (97-138kPa) with a radiator tester.
c. If seawater begins to overflow from the nipple there is a leak.

For Blockage:

IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flow AROUND the tubes.

a. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
b. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

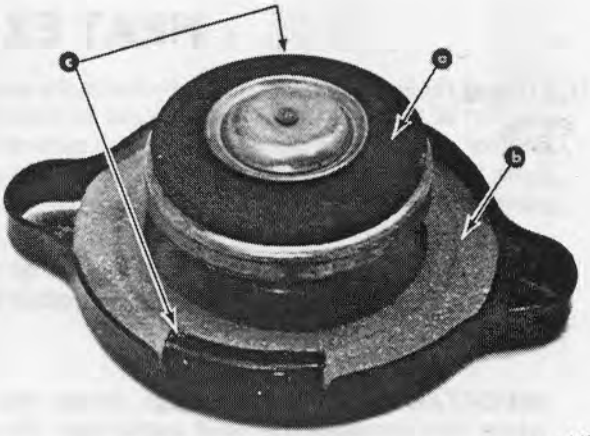
TESTING PRESSURE CAP

Pressure cap is designed to maintain a pressure of approximately 14 psi (97 kPa) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure, as follows:

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Carefully remove pressure cap from reservoir.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. (Figure 1) Replace gasket, if damaged, or entire cap, if rubber seal is damaged.



14961

a - Rubber Seal (Cap MUST BE Replaced if damaged)
b - Gasket (Look For Cracks Under Gasket)
c - Locking Tabs (1 Hidden)

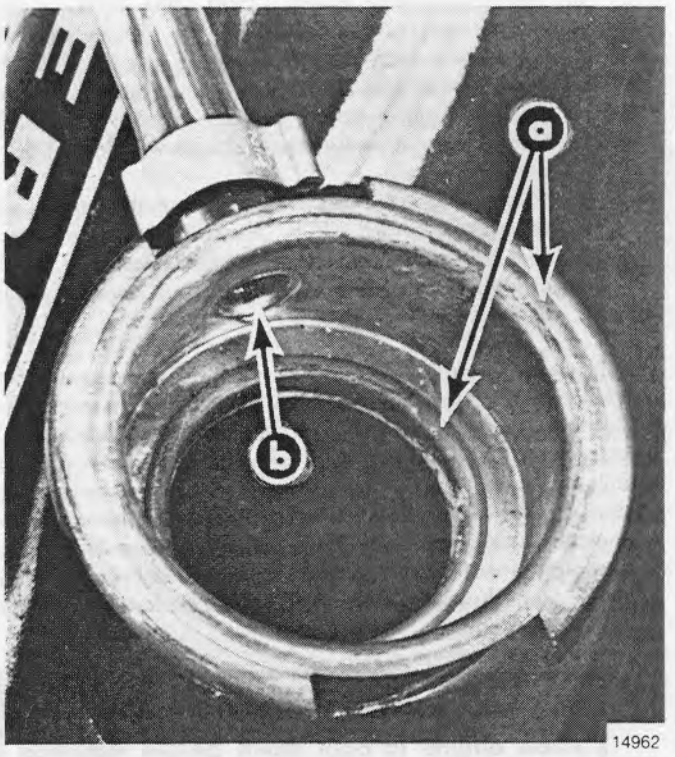
Figure 1. Pressure Cap

5. Using a cooling system pressure tester (similar to one shown in Figure 2), test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap MUST relieve pressure between 11 and 17 psi (76-117 kPa) and must hold rated pressure for 30 seconds without going below 11 psi. Replace cap if it fails to fall with these limits.

Figure 2. Pressure Testing Pressure Cap

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent (Figure 3).

6. Reinstall cap on reservoir.



a - Inspect for Damage b - Clean Coolant Recovery Passage

Figure 3. Heat Exchanger

HEAT EXCHANGER REPAIR

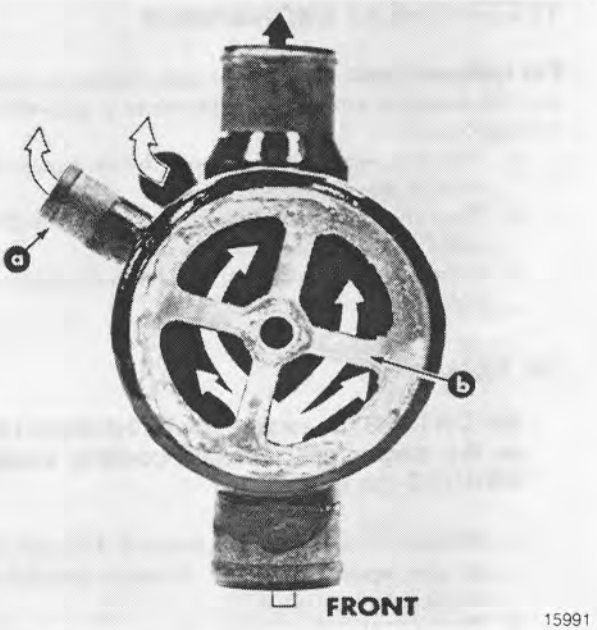
1. Freezing the seawater circuit usually forces the end castings out of the shell. These castings can be cleaned, reinserted properly and brazed in place by a radiator shop. Refer to Figure 1, 2, 3 or 4 for proper placement of end castings.

IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

IMPORTANT: The end castings directs the seawater flow through the heat exchanger. On stern drive (MCM) engines, if they aren't installed correctly, the water takes a short cut and two-thirds (or more) of the exchanger is not used.

- **MIE engines, seawater passes through exchanger once before leaving. (Figure 1)**
- **MCM engines with a 3" (76mm) dia. heat exchanger, seawater passes through exchanger three (3) times before leaving. (Figure 2 or 3)**
- **MCM engines with a 4" (102mm) dia. heat exchanger, seawater passes through exchanger five (5) times before leaving. (Figure 4)**

2. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. DO NOT close more than 3 tubes.
3. Nipples and drains, that have been broken off the heat exchanger, can be re-attached by brazing.

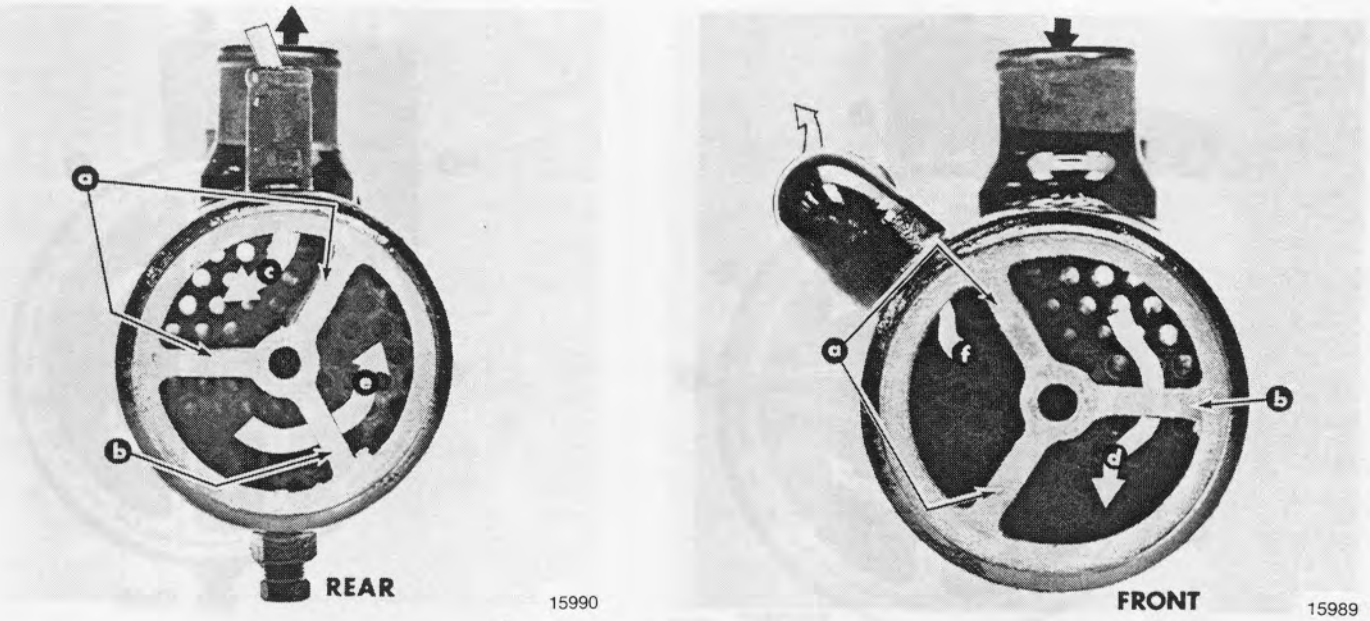


Closed Cooling Coolant Flow

Seawater Flow

a - Small Amount of Seawater to Cool Voltage Regulator
b - All 4 Ribs Are Open

Figure 1. 78165 End Casting Placement [MIE 470 3" (76mm) Dia.]

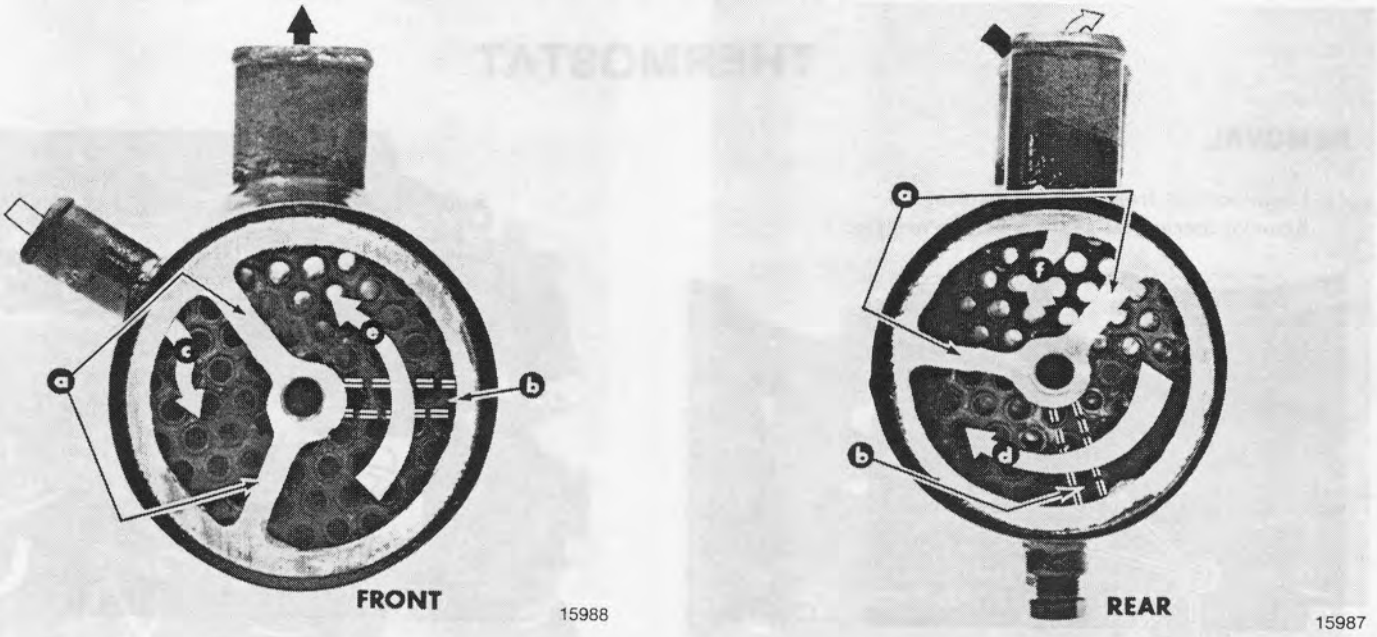


Closed Cooling Coolant Flow

Seawater Flow

a - Solid Ribs
b - Open Rib
c - Flows to Front
d - Flows to Rear
e - Flows to Front
f - Flows to Exhaust Elbow

Figure 2. 75959 End Casting Placement [MCM 470 3" (76mm)

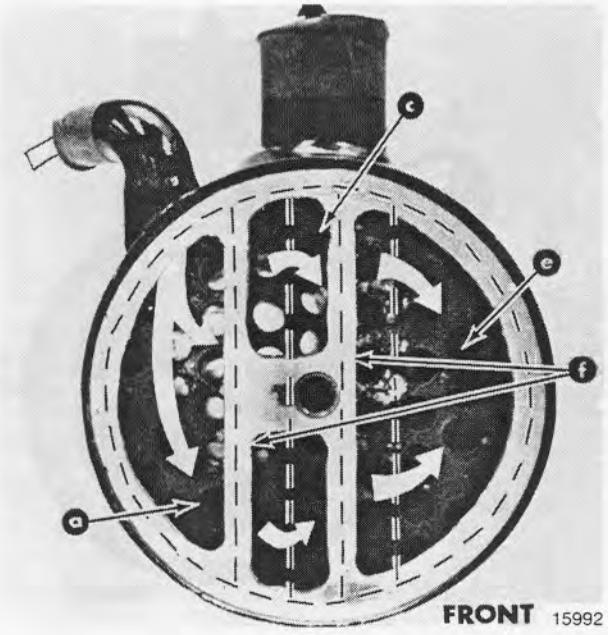


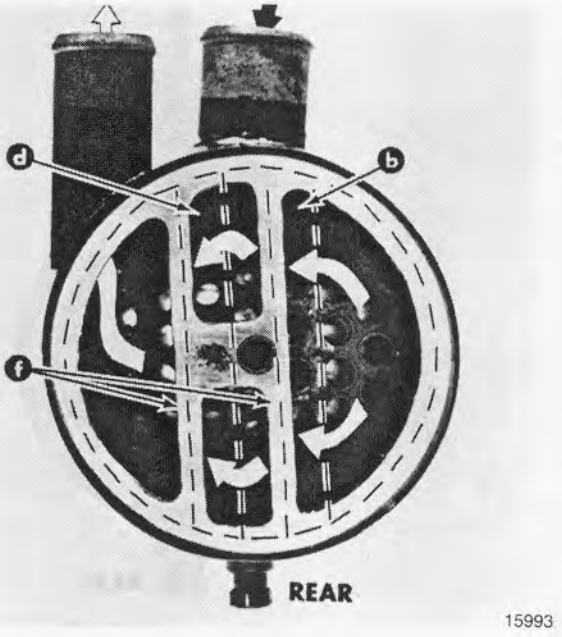
Closed Cooling Coolant Flow

Seawater Flow

a - Sold Ribs
b - Open Rib (If Exchanger Has 3rd Rib At Each End)
c - Flows to Rear
d - Flows to Front
e - Flows to Rear
f - Flows to Exhaust Elbow

Figure 3. 77319 End Casting Placement [MCM 470/485 3" (76mm) Dia.]





Closed Cooling Coolant Flow

Seawater Flow

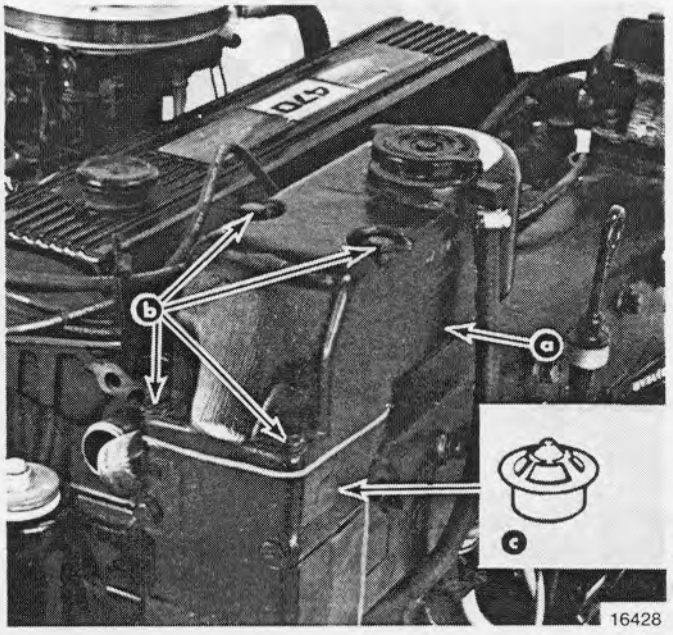
a - 17 Tube Flow to Rear
b - 8 Tube Flow To Front
c - 9 Tube Flow To Rear
d - 8 Tube Flow To Front
e - 17 Tube Flow To Rear
f - The Two Ribs On Each End Are Solid

Figure 4. 98643 End Casting Placement [MCM 470/488 4" (102 mm) Dia.]

THERMOSTAT

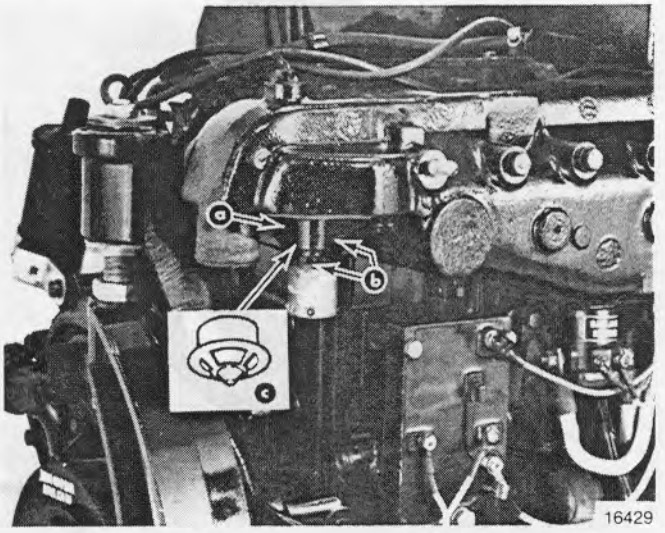
REMOVAL

1. Drain coolant from exhaust manifold.
2. Remove thermostat as shown in Figure 1 or 2.



a - Reservoir b - Remove Bolts (4) c - Remove Thermostat

Figure 1. MCM/MIE 470

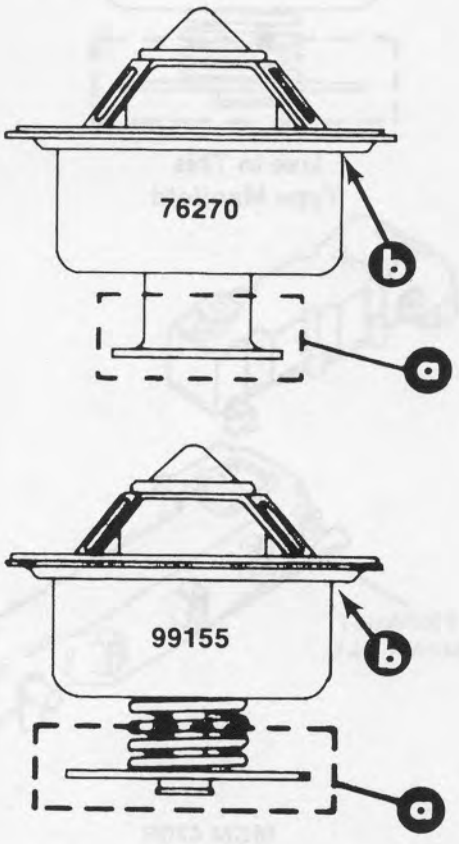


a - Thermostat Housing b - Remove Bolts (2)
c - Remove Thermostat

Figure 2. MCM 470R/485/488R

TESTING

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Check for light leakage around thermostat valve. Light leakage indicates thermostat should be replaced. (Figure 3) (A small amount of leakage at 1 or 2 points around valve perimeter is acceptable).
3. Check condition of umbrella. (Figure 3) If damaged, replace thermostat.



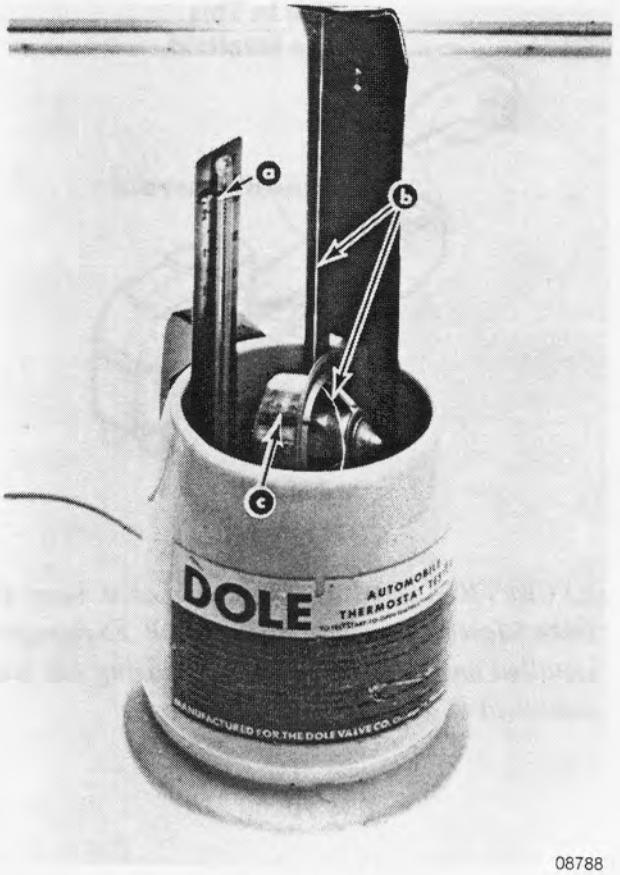
a - Check Umbrella
b - Check for Light Leakage

Figure 3. Thermostats

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown in Figure 4), as follows:
   a. Fill tester to within 1" (25mm) of top with tap water. DO NOT use distilled water.
   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.
   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. DO NOT allow thermometer to touch container.

IMPORTANT: When performing Steps d and e, water MUST BE agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat MUST open at 155° - 162° F (68° - 72° C). Thermostat must be completely open at 182° F (83° C).
   e. Unplug tester and allow water to cool to a temperature 10° F (5° C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
   f. Replace a thermostat that fails to meet all of the preceding tests.



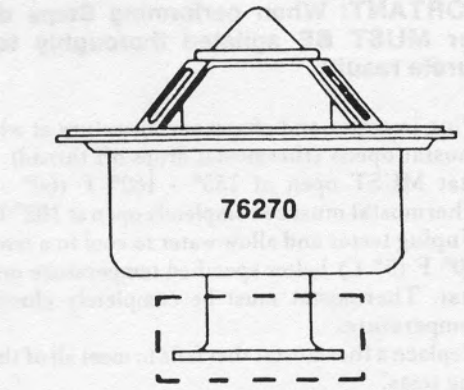
08788

a - Thermometer
b - Nylon String
c - Thermostat

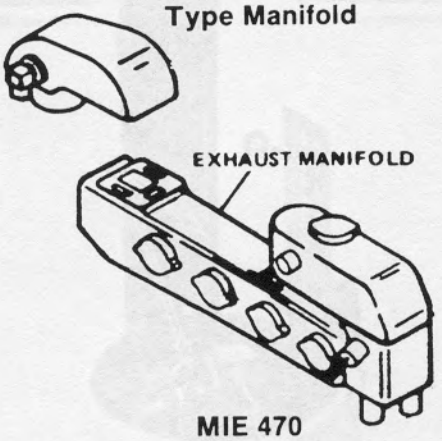
Figure 4. Thermostat Tester

IDENTICATION

Because there is a difference in operation and design of the two thermostats offered, care must be taken when ordering replacement parts. (Figure 5 and 6)



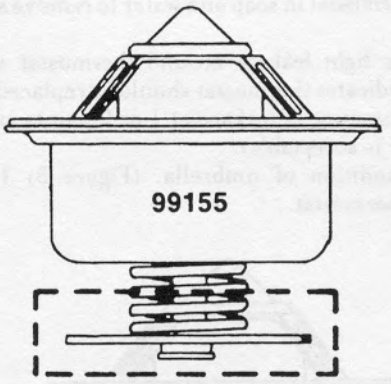
Use In This Type Manifold



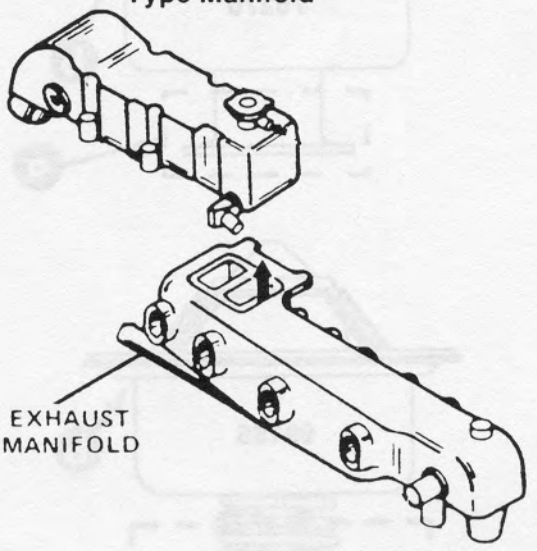
MIE 470
MCM 470

Figure 5.

EXCEPTION: MCM 470 Models that have Heavy Duty Closed Cooling (4" dia. Heat Exchanger) Kit installed on engine. Thermostat housing (in kit) was machined to accept 99155 thermostat.



Use In This Type Manifold



MCM 470R
MCM 485
MCM 488R

Figure 6

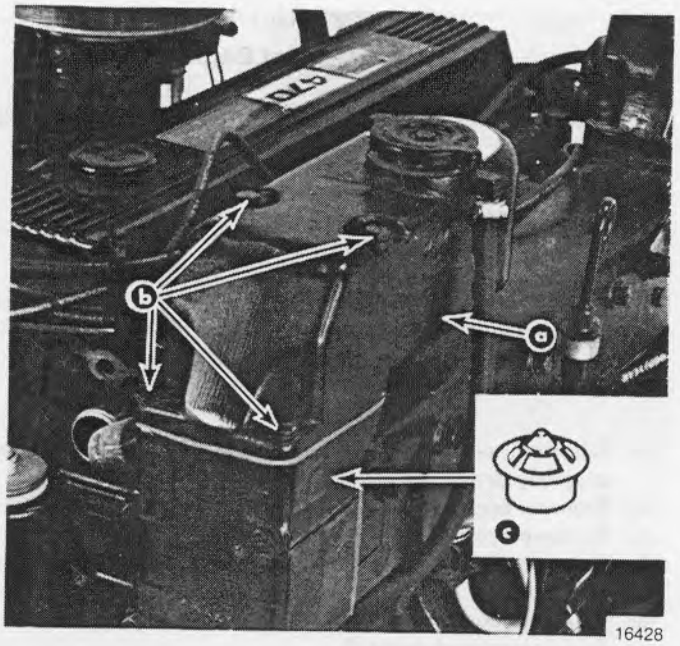
INSTALLATION

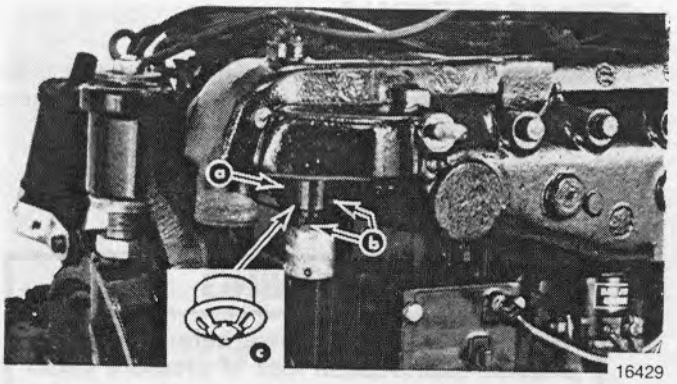
1. Clean all gasket surfaces.
2. Install thermostat as shown in Figure 7 or 8.
3. Refill closed cooling section as outlined in "Changing Coolant see Index.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged.

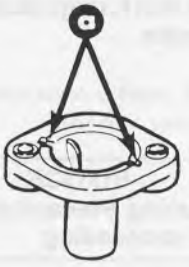
4. Start engine and inspect for leaks.





a - Thermostat Housing - Coat Both Sides of New Gasket with Perfect Seal. (See Figure 9 Before Installing)
b - Torque Bolts to Specifications
c - Install Thermostat with Umbrella Up

Figure 8. MCM 470R/485/488R



a - 3/16" Slots Must Be Clean or Engine May Overheat

Figure 9. Slots in Thermostat Housing.

a - Reservoir - Coat both sides of New Gasket
b - Torque Bolts to Specifications
c - Install Thermostat with Umbrella Down

Figure 7. MCM/MIE 470

CHANGING COOLANT

COOLANT RECOMMENDATION

It is recommeded that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

⚠CAUTION

Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in closed cooling section at any time.

Listed below are the current brands of permanent type anti-freeze solutions that are approved for use in aluminum component MerCruiser engines. DO NOT MIX the new anti-freeze solution with the old solution or it will cause small particles to form in the coolant. These small particles can settle in the heat exchanger and restrict coolant flow. Drain and flush the old anti-freeze solution from the closed cooling system.

PRESTONE II

PEAK (Produced after January, 1981)

or any brand anti-freeze solution that meets G.M. specification 1825M.

CHANGE INTERVALS

The old coolant should be drained and flushed from the closed cooling system at least every two (2) years or whenever exhaust gases have entered into the system.

DRAINING PRECAUTIONS

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

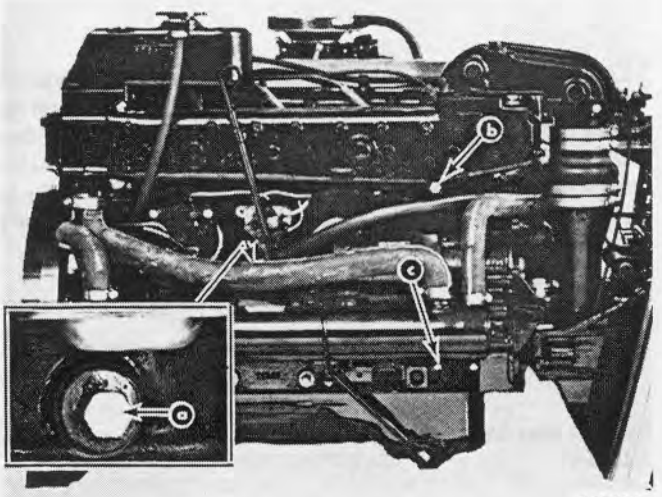
IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes.

NOTE: If possible, place a container under drains to prevent coolant from draining into boat.

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

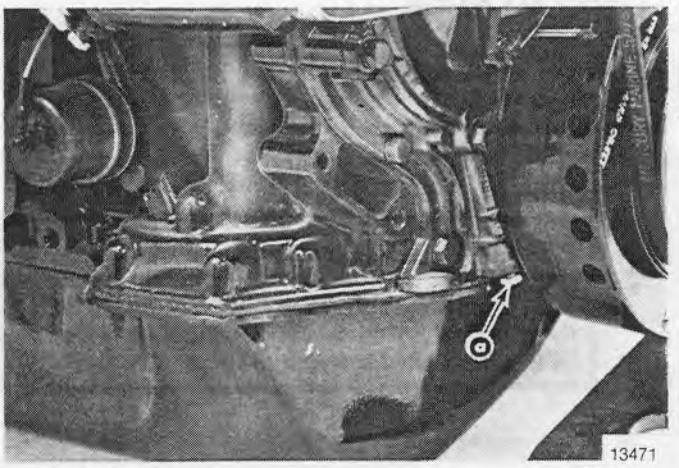
MCM/MIE 470

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Remove drain plugs as shown in Figures 1 and 2.
4. Remove coolant recovery reservoir from bracket and pour out coolant.
5. After coolant has drained completely, coat threads of all drain plugs and reinstall.
6. Clean system as outlined in "Cleaning System".



a - Drain Plug (1) b - Drain Plug (1) c - Drain Plug (1)

Figure 1. Port Side



a - Drain Plug (1)

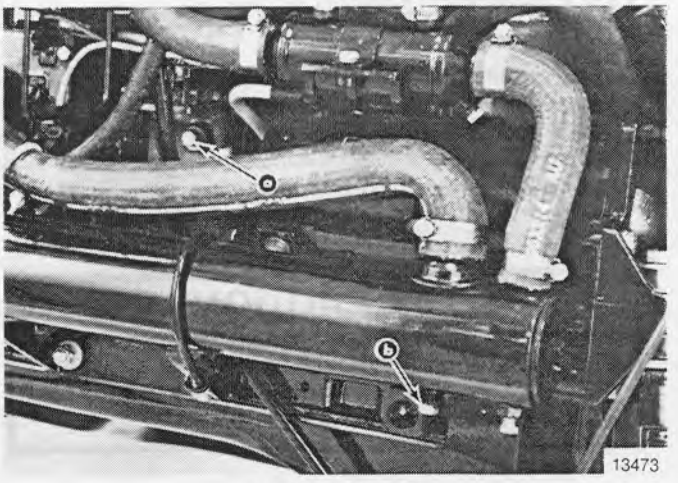
Figure 2. Front of Engine

7. Refill system as outlined in "Filling Closed Cooling System".

MCM 470R/485/488R

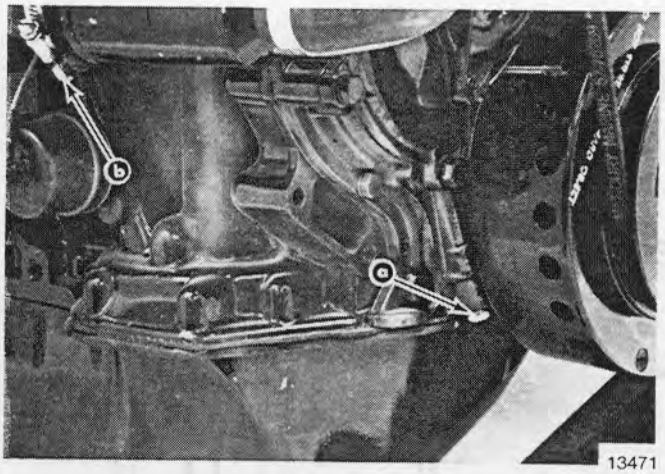
NOTICE
Refer to "Draining Precautions", in theis section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Remove drain plugs as shown in Figures 3 and 4.
4. Remove coolant recovery reservoir from bracket and pour out coolant.
5. After coolant has drained completely, coat threads of all drain plugs and reinstall.
6. Clean system as outlined in "Cleaning System".
7. Refill system as outlined in "Filling Closed Cooling System".



a - Drain Plug (1)
b - Drain Plug (1)

Figure 3. Port Side



a - Drain Plug (1)
b - Drain Plug (1) - (MCM 485 Only)

Figure 4. Front of Engine

CLEANING SYSTEM

CLOSED COOLING SECTION

Closed cooling section of Closed Cooling System should be cleaned at least once every 2 years or whenever decreased cooling efficiency is experienced.
A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Manufacturer's instructions, which accompany particular cleaner, always should be followed.

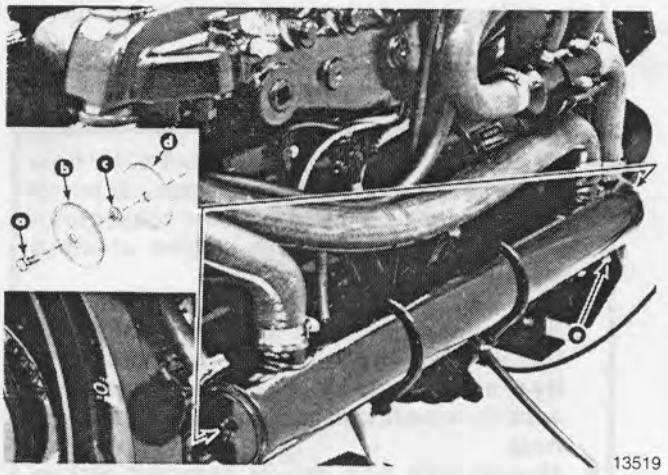
If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hook-up and flushing procedure.

SEAWATER SECTION

Cooling efficiency of an engine with Closed Cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned at least once every 2 years or whenever decreased cooling efficiency is suspected, as follows:

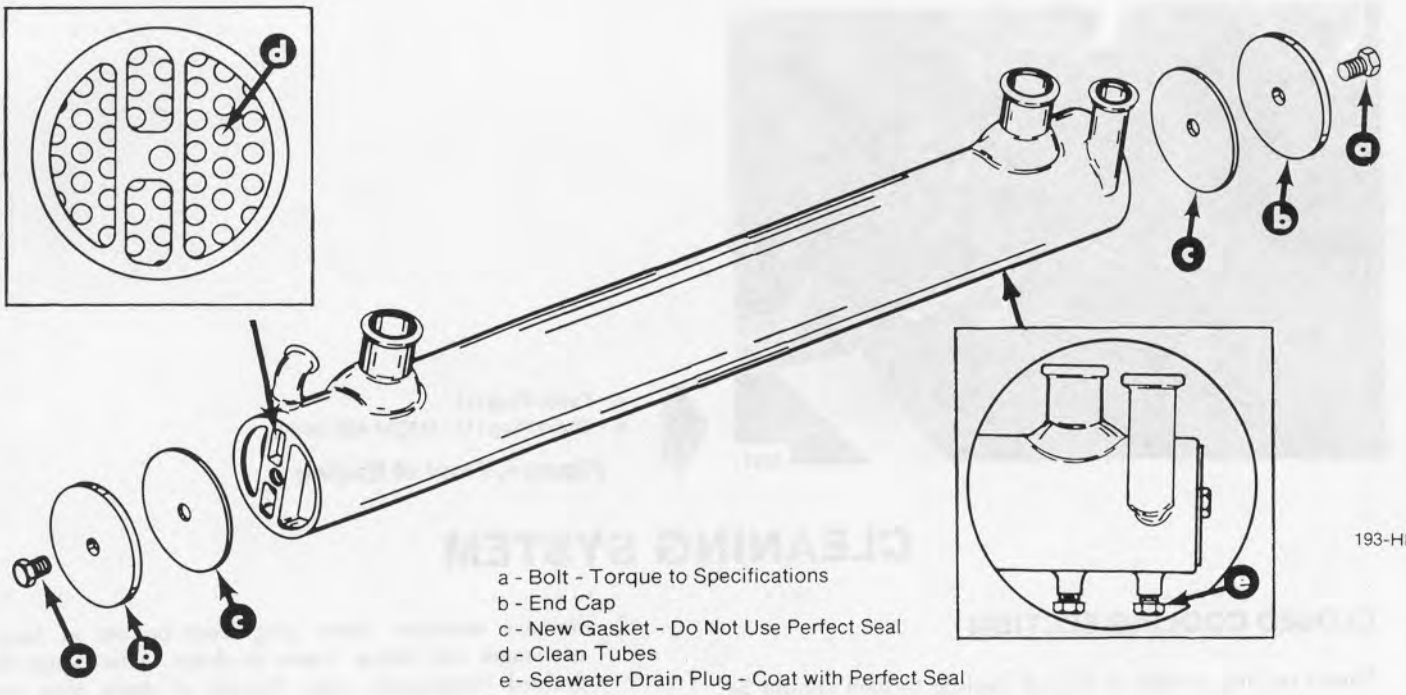
IMPORTANT: It may be necessary to remove heat exchanger on some models. If heat exchanger is removed, be sure to refill closed cooling section with coolant.

1. Remove seawater drain plug from bottom of heat exchanger and allow water to drain. After water has drained completely, coat threads of drain plug with Perfect Seal and reinstall. (Figure 1 or 2)
2. Remove bolts, which secure end plates to each end of heat exchanger, then remove end plates, seal washers and gaskets. Discard seal washers and gaskets. Clean gasket material from end plates and heat exchanger.
3. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
4. Using new gaskets (and sealing washers, some models), install end plates as shown in Figure 1 or 2.
5. Start engine and inspect cooling system for leaks.



a - Bolt - Torque to Specifications
b - End Cap (MIE 470 Only Has 1 End Cap)
c - New Sealing Washer
d - New Gasket - Coat Both Sides with Perfect Seal
e - Seawater Drain Plug - Coat with Perfect Seal

Figure 1. 3" (76mm) Dia. Heat Exchanger



a - Bolt - Torque to Specifications
b - End Cap
c - New Gasket - Do Not Use Perfect Seal
d - Clean Tubes
e - Seawater Drain Plug - Coat with Perfect Seal

Figure 2. 4" (102mm) Dia. Heat Exchanger

FILLING CLOSED COOLING SECTION

NOTICE
See "Specifications" for approximate closed cooling system capacity.

1. Fill closed cooling section with coolant thru reservoir filler neck until coolant solution is 1" (25mm) below filler neck.

⚠CAUTION

- **DO NOT operate engine without water flowing thru seawater pickup pumps, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.**
- **Engine should be as level as possible to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.**
- **Models with belt driven seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.**

2. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to reservoir, as required, to maintain coolant level 1" below filler neck.
3. After engine has reached normal operating temperature (thermostat is fully open), and coolant level remains constant, fill reservoir to bottom of filler neck.
4. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
5. Install pressure cap on reservoir.
6. Remove cap from coolant recovery reservoir and fill to "Full" mark with coolant solution. Reinstall cap.
7. With engine still running, check hose connections, fittings and gaskets for leaks. Repeat step 4.

IMPORTANT: Engine overheating is often due to air being trapped in fresh water section. Purge air by running engine at 2000 RPM for 10 minutes.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

8. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
9. Maintain coolant level in coolant recovery reservoir between "Add" and "Full" marks with engine at normal operating temperature.

OUT-OF-SEASON STORAGE

CLOSED COOLING SECTION

Closed cooling section of closed cooling system should be kept filled year around with recommended coolant solution. DO NOT drain closed cooling section for storage. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol anti-freeze and water solution, mixed to manufacture's recommended proportion, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

SEAWATER SECTION DRAINING PRECAUTIONS

IMPORTANT: If the possibility of freezing exists, seawater section MUST BE drained to prevent freeze damage to cooling system and engine. Seawater section also should be drained if boat is to be stored for an extended period of time, to prevent corrossion damage.

⚠CAUTION

Cooling system, MUST BE completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine.

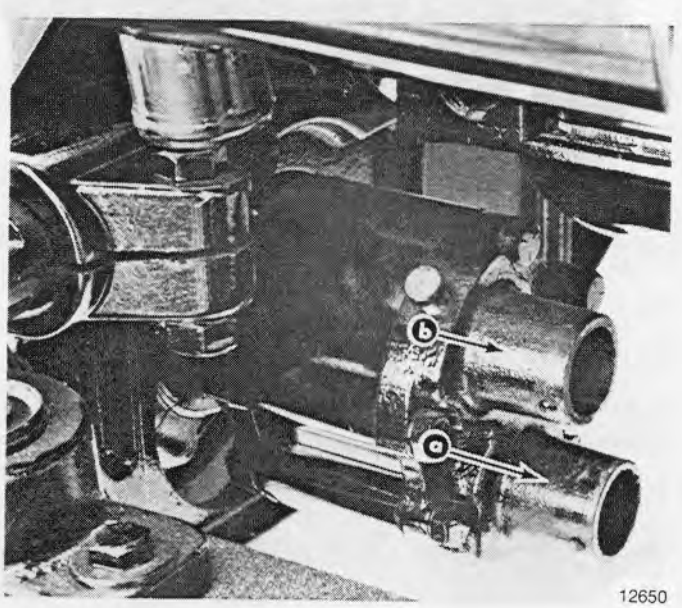
⚠CAUTION

If boat is in the water, water inlet valve (if so equipped) MUST be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose MUST BE left disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve MUST BE opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes.

IMPORTANT: To prevent threads in elbows from rusting out during storage, reinstall plugs using Perfect Seal on threads. NEVER leave drain plugs out during storage.

NOTE: If possible, place a container under drains to prevent water from draining into boat.



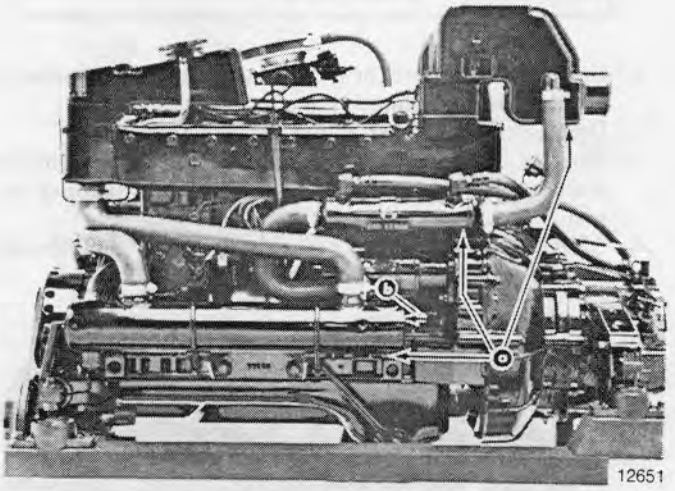
a - Remove Inlet Hose, Lower to Drain
b - Remove Outlet Hose, Lower to Drain

Figure 2. MIE 470

MIE 470

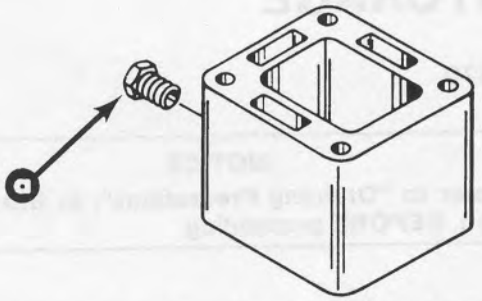
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 1, 2, and 3.
3. Remove heat exchanger end caps (to ensure complete draining) and clean tubes as outlined in 'Cleaning System".
4. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hose and tighten clamp securely.



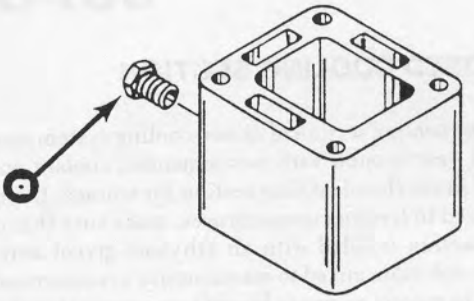
a - Remove Drain Plugs
b - Remove End Cap

Figure 1. MIE 470



a - Remove Drain Plug

Figure 3. 3″ or 6″ Risers (If Equipped)



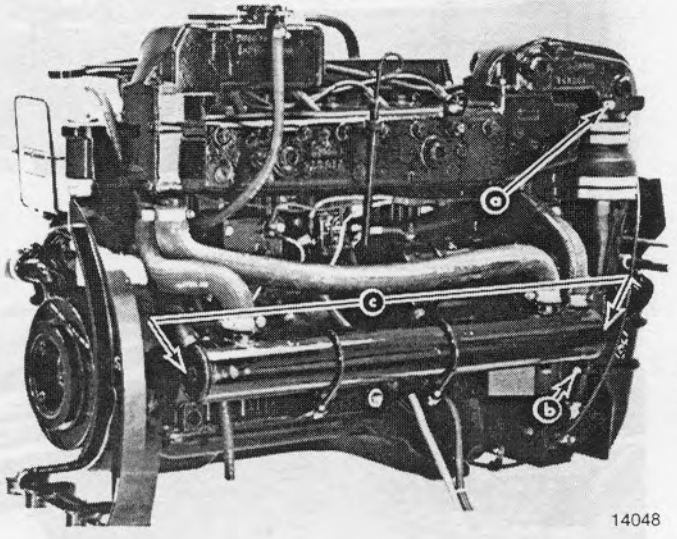
a - Remove Drain Plug

Figure 5. 3″ or 6″ Riser (If Equipped)

MCM 470

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 4, 5 and 6.
3. Remove heat exchanger end caps (to ensure complete draining) and clean tubes as outlined in "Cleaning System".
4. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall.



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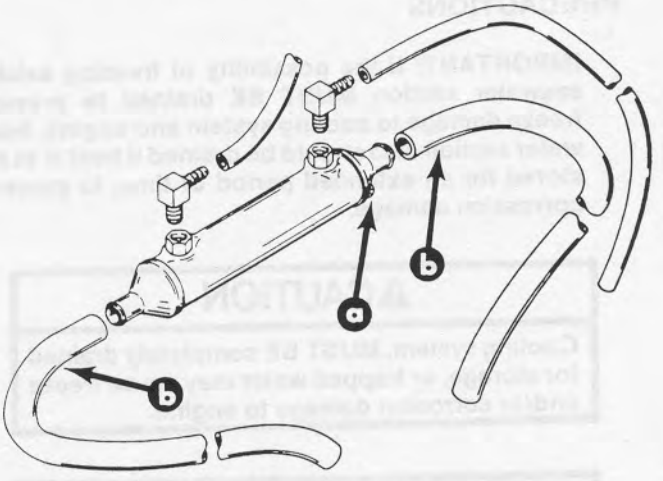
a - Remove Drain Plug [Later Low-Profile Exhaust Elbow (Shown) Did Not Have a Drain Plug Because it Drained itself]
b - Remove Drain Plug (1)
c - Remove End Caps

Figure 4. MCM 470



a - Remove Drain Plug
b - Cooler Without Drain Plug - Remove Hoses, Lower to Drain

Figure 6. Power Steering Fluid Cooler (If Equipped)

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figure 7.
3. Remove heat exchanger end caps (to ensure complete draining) and clean tubes as outlined in "Cleaning System".
4. After cooling system has drained completely, coat threads of drain plug with Perfect Seal and reinstall.

a - Remove Drain Plug (1) (Some Early Model 4" Dia. Heat Exchangers Did Not Have Drain Plug, End Caps Have to be Removed
b - Remove End Cap (Both Ends)
c - Remove Drain Plug (Power Steering Models Only)

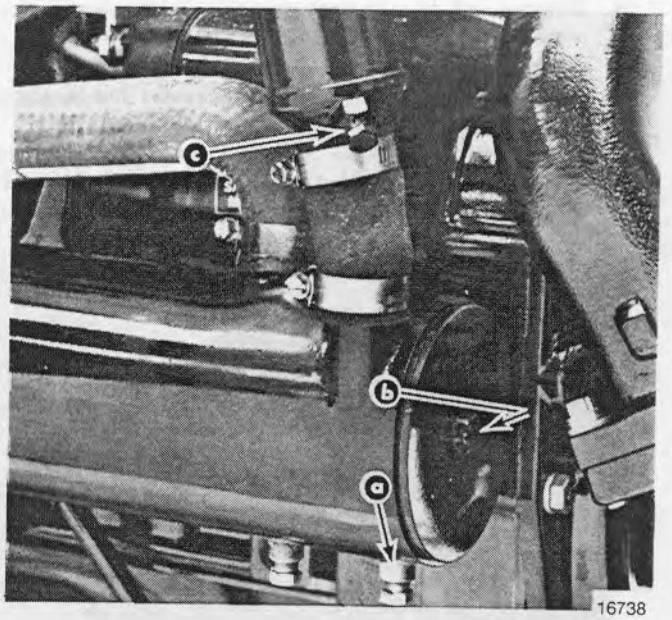


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Figure 7. MCM 470R/485/488R

HEAVY DUTY CLOSED COOLING KIT (41525A1)

This kit is designed for use on the MCM 470/485 Only

1. Drain cooling system.
2. Remove and retain hoses "A", "B", "E" and "F". (Figure 1 or 2)
3. Remove and discard hoses "C" and "D". (Figure 1 or 2)

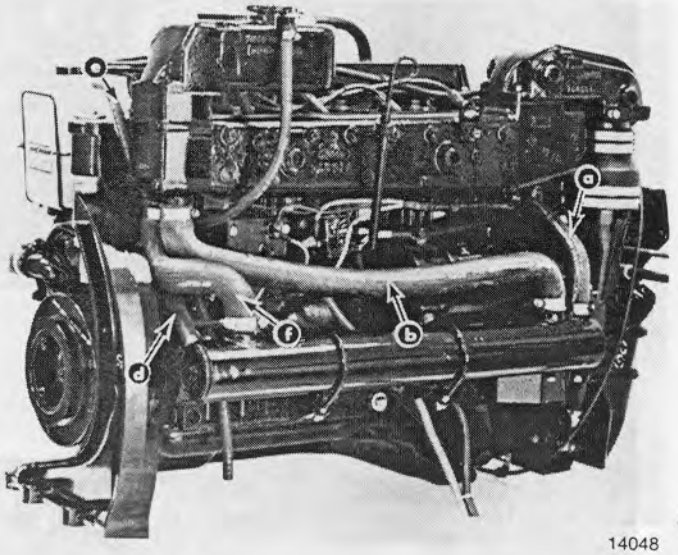

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Figure 1. Removing Cooling System Hoses (MCM 470)

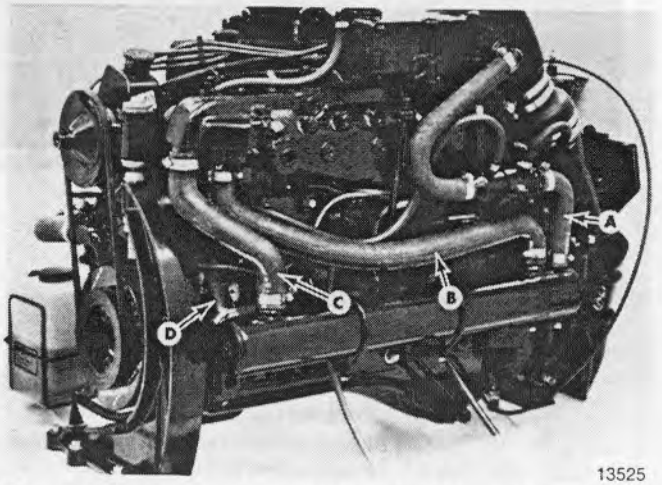

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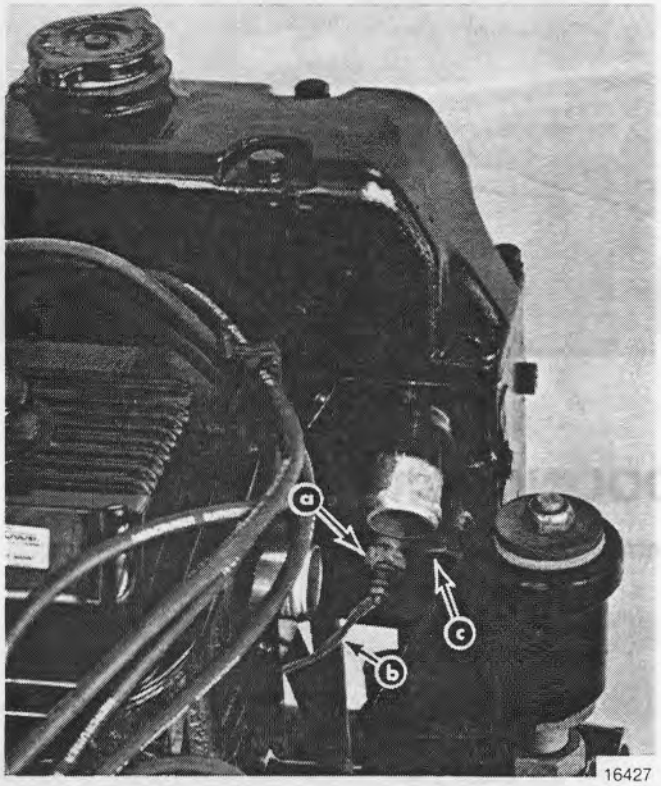
Figure 2. Removing Cooling System Hoses (MCM 485)

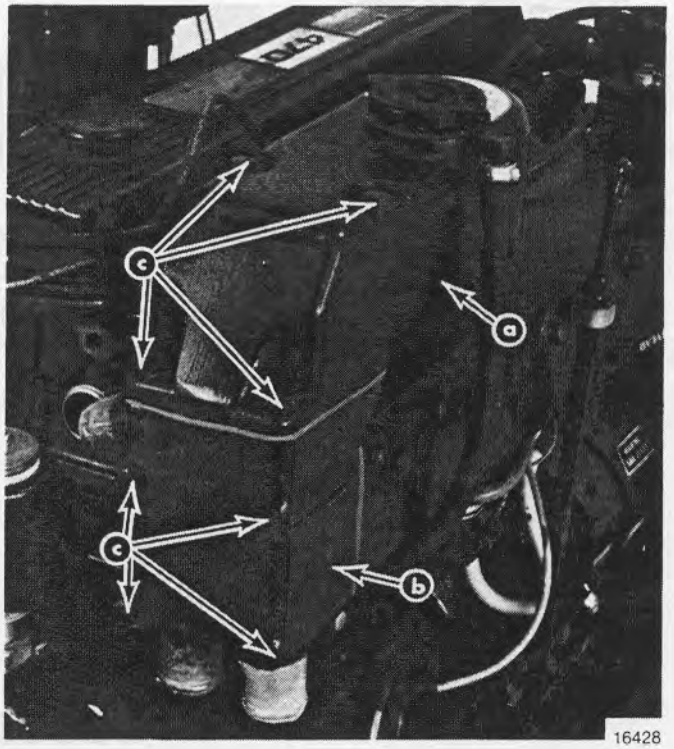
4. Remove and discard heat exchanger and mounting hardware.
5. A) MCM 470:
    1. Remove water temperature sender and thermostat housing plug from location shown in Figure 3.
    2. Remove screws and lockwashers which secure reservoir and thermostat housing assemblies. (Figure 4) Discard thermostat housing and thermostat.



a - Water Temperature Sender
b - Water Temperature Sender Wire
c - Thermostat Housing Plug

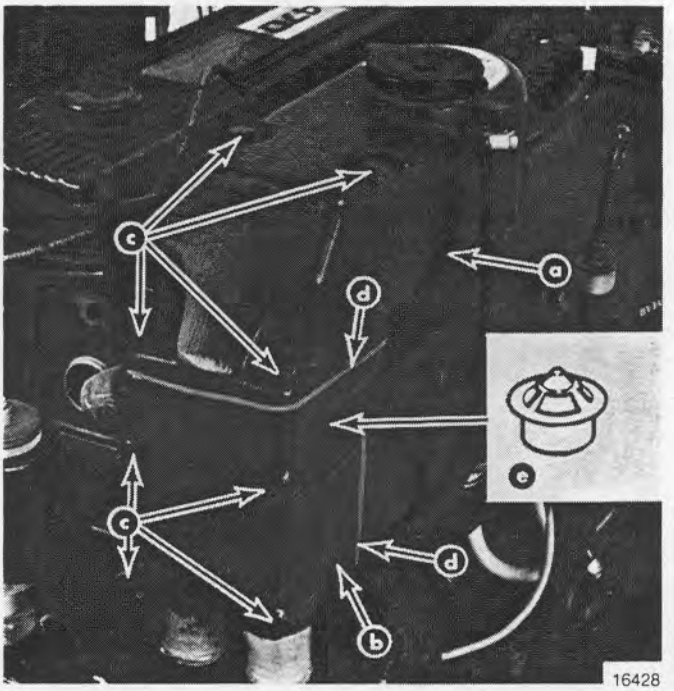
Figure 3. Water Temperature Sender and Plug Removal

    3. Clean ALL gasket material from reservoir and exhaust manifold surfaces.
    4. Apply Perfect Seal or equivalent to BOTH sides of the two (2) large gaskets in kit.
    5. Install NEW thermostat housing, thermostat, gaskets and the original reservoir assembly. (Figure 5) Torque screw to 15-20 lbs. ft. (20-27 N.m).
    6. Apply teflon tape to threads of temperature sender and plug; then install in thermostat housing. (Figure 6)
    7. Connect temperature sender wire and coat connection with Liquid Neoprene (Figure 6)
5. B) MCM 485
    1. Remove screws and lockwasher which secure thermostat housing. (Figure 7)
    2. Remove and discard thermostat.
    3. Clean ALL gasket material from thermostat housing and exhaust manifold surfaces.
    4. Apply Perfect Seal or equivalent to BOTH sides of the small gasket in kit.
    5. Install thermostat housing, NEW thermostat and gasket. (Figure 8) Torque screws to 15-20 lbs. ft. (20-27 N.m).



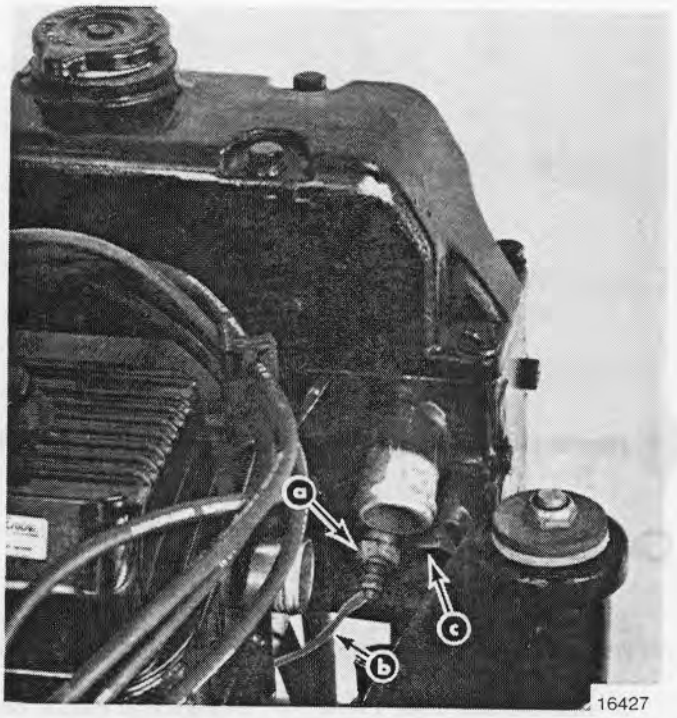
a - Reservoir Assembly
b - Thermostat Housing Assembly
c - Screws and Lockwashers

Figure 4. Removing Reservoir and Thermostat Housing Assemblies (MCM 470)



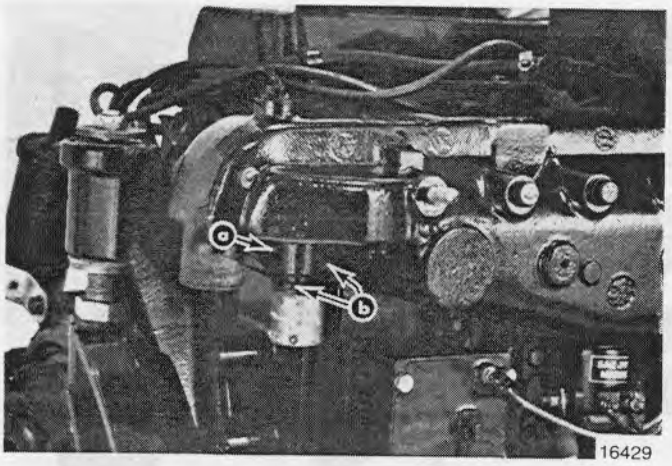
a - Reservoir Assembly (Original)
b - Thermostat Housing Assembly (From Kit)
c - Screws and Lockwashers (Original)
d - Gaskets (Hidden; From Kit)
e - Thermostat (From Kit)

Figure 5. Installing Reservoir and Thermostat Housing Assemblies (MCM 470)



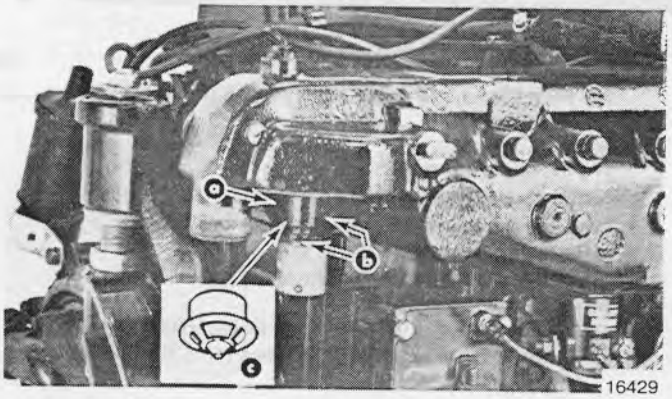
a - Water Temperature Sender
b - Water Temperature Sender Wire
c - Thermostat Housing Plug

Figure 6. Installing Temperauture Sender and Plug



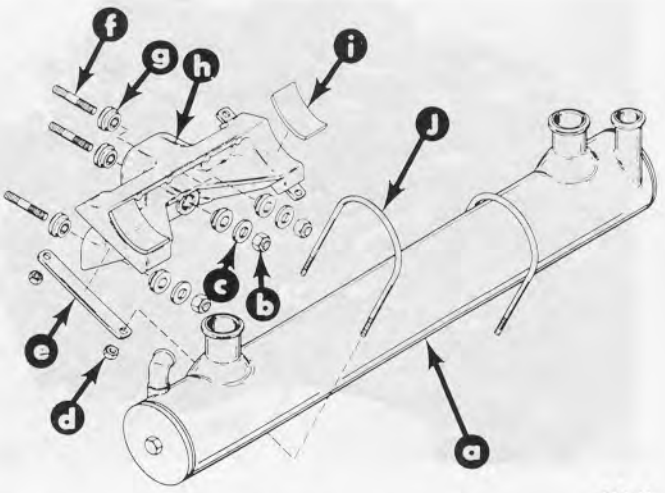
a - Thermostat Housing
b - Screws and Lockwashers

Figure 7. Removing Thermostat Housing (MCM 485)



a - Thermostat Housing and New Gasket
b - Screws and Lockwashers
c - Thermostat (From Kit)

Figure 8. Installing Thermostat Housing (MCM 485)



a - Heat Exchanger
b - Lock Nut (3)
c - Flat Washer (3)
d - Nut (4)
e - Strap
f - Stud (3)
g - Vibration Mount (6)
h - Heat Exchanger Mounting Bracket
i - Heat Exchanger Mounting Pad (2)
j - U-Bolt

Figure 9. Installing Heat Exchanger

6. Install NEW heat exchanger and mounting hardware. (Figure 9)
7. Install ORIGINAL hoses "A", "B", "E" and "F". (Figure 10 or 11) Tighten all hose clamps securely.
8. Install NEW hoses "C" and "D" (from kit). (Figure 10 or 11) Tighten all hose clamps securely.
9. Fill closed cooling system with coolant.

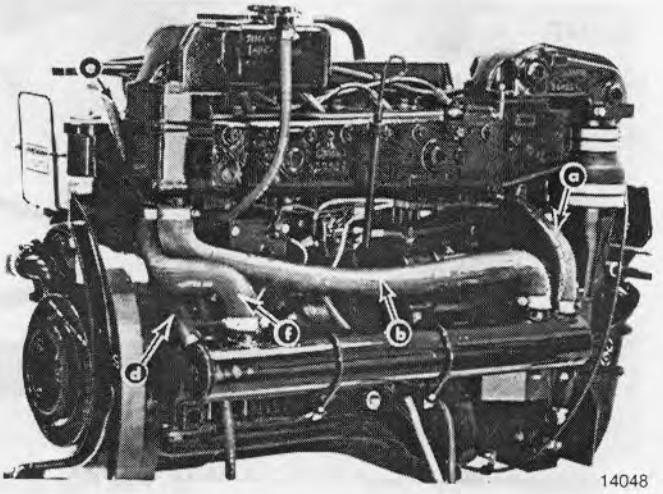


Figure 10. Installing Cooling System Hoses (MCM 470)

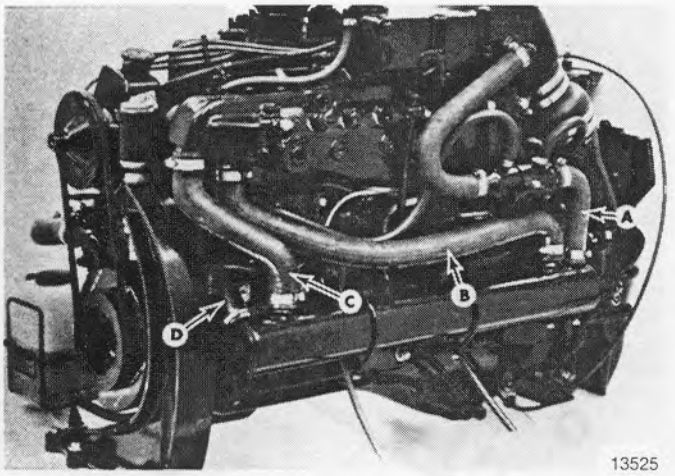


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Figure 11. Installing Cooling System Hoses (MCM 485)

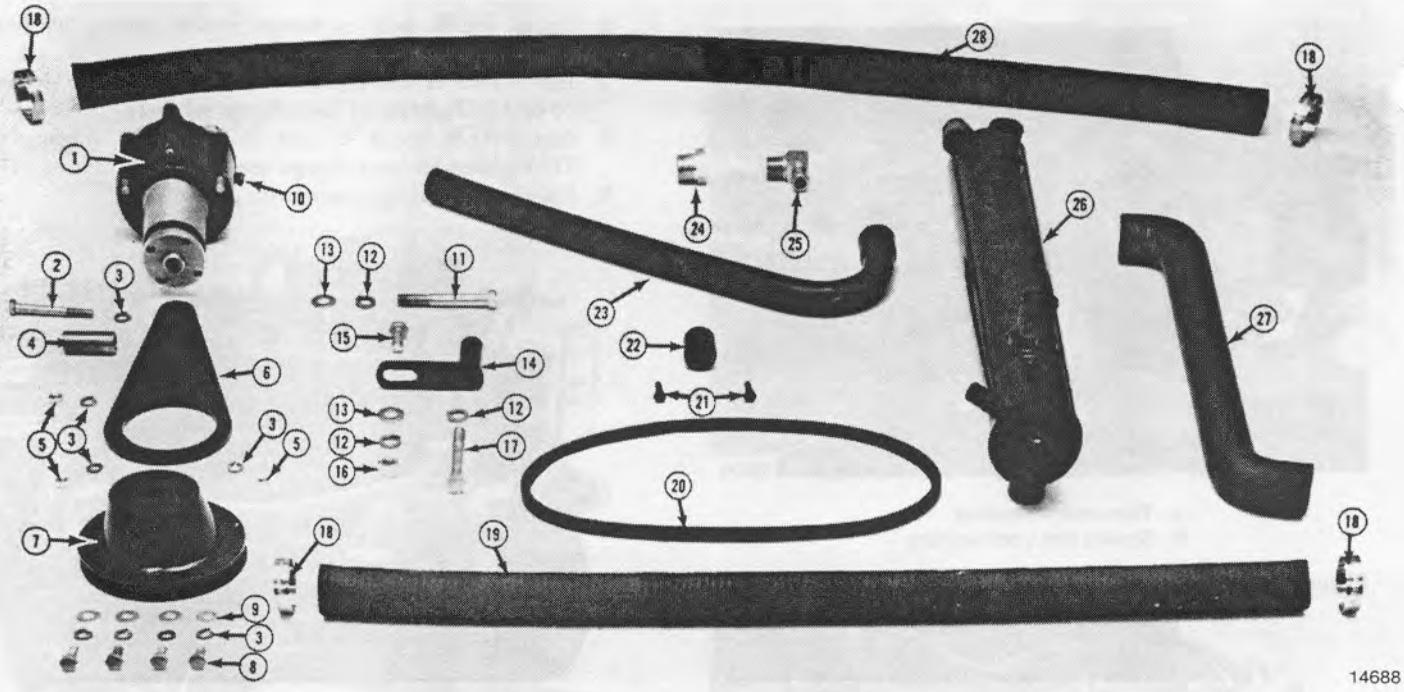
MCM 470 HEAVY-DUTY COOLING KIT (78165A1)

IMPORTANT: This kit is no longer available.

⚠WARNING

Disconnect both battery leads from battery to prevent accidental shorting of wires during installation.

1. Drain cooling system.
2. Remove and discard hose "A" in Figure 2. Retain hose clamps.
3. Remove and discard hose "B" in Figure 2. Retain hose clamps.
4. Disconnect hoses ("C" and "D" in Figure 2) which connects voltage regulator and thermostat housing to heat exchanger. Retain hose clamps.



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1 - Seawater Pickup Pump
2 - Screw (10-89318)
3 - Lockwasher (13-39107)
4 - Spacer (23-96014)
5 - Nut (11-21908)
6 - Seawater Pickup Pump Bracket (96012)
7 - Pulley (71137)
8 - Screw (10-26065)
9 - Flat Washer (4 Req'd) (12-26825)
10 - Pipe Plug (22-32802)
11 - Screw (10-95961)
12 - Lockwasher (13-32993)
13 - Flat Washer (12-27025)
14 - Sea Pump Brace (96013)
15 - Screw (10-47461)
16 - Nut (11-29553)
17 - Screw (10-60179)
18 - Hose Clamps (54-32780)
19 - Heat Exchanger to Seawater Pickup Pump Outlet Hose (40") (32-54149)
20 - V-Belt (57-60327)
21 - Screws (10-53556)
22 - Rubber Grommet (32877)
23 - Heat Exchanger to Exhaust Elbow Hose (32-96143)
24 - Reducing Bushing (22-78173)
25 - Connector, Elbow (90°) (22-32715)
26 - Heat Exchanger (78165)
27 - Heat Exchanger to Thermostat Housing Hose (32-78109)
28 - Seawater Pickup Pump Inlet Hose (48") (32-53461)

Figure 1. Heavy-Duty Cooling Kit Parts Assembly View

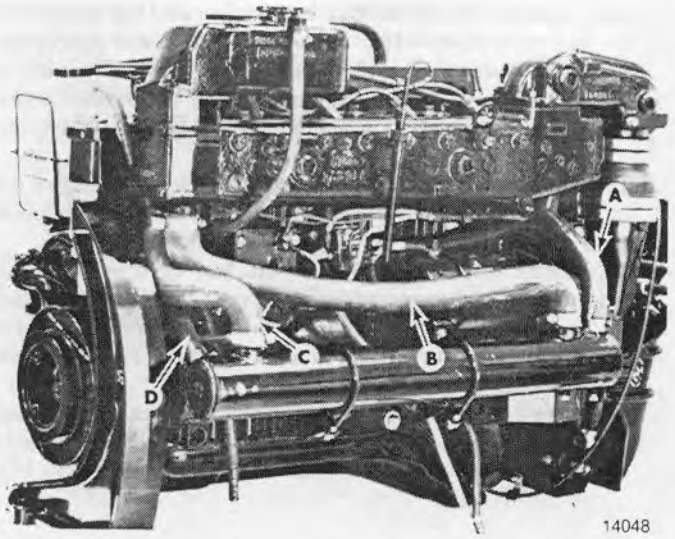
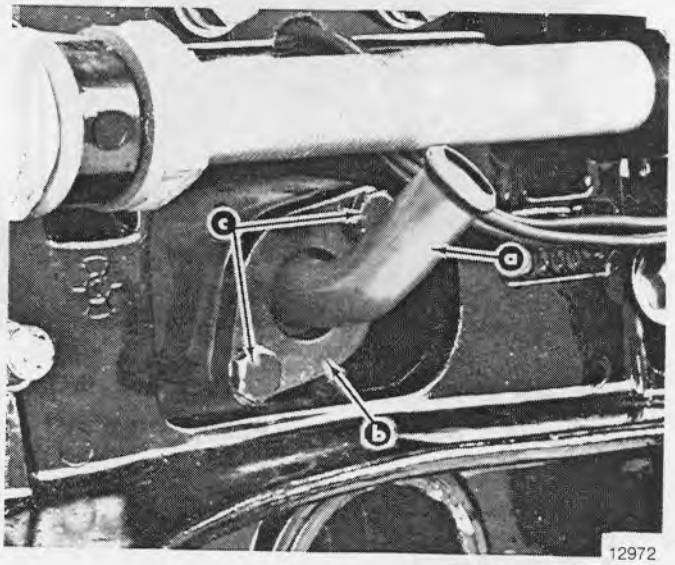


Figure 2. MCM 470 Standard Closed Cooling Hose Locations

5. Remove (and retain) "U" bolts, elastic stop nuts and clamping straps which secure heat exchanger to engine. Remove and discard heat exchanger.
6. Disconnect voltage regulator hose from water pickup tube. Retain hose clamp.
7. Remove (and discard) 2 bolts, that secure water pickup tube cover to inner transom plate (Figure 3). Remove (and retain) cover.



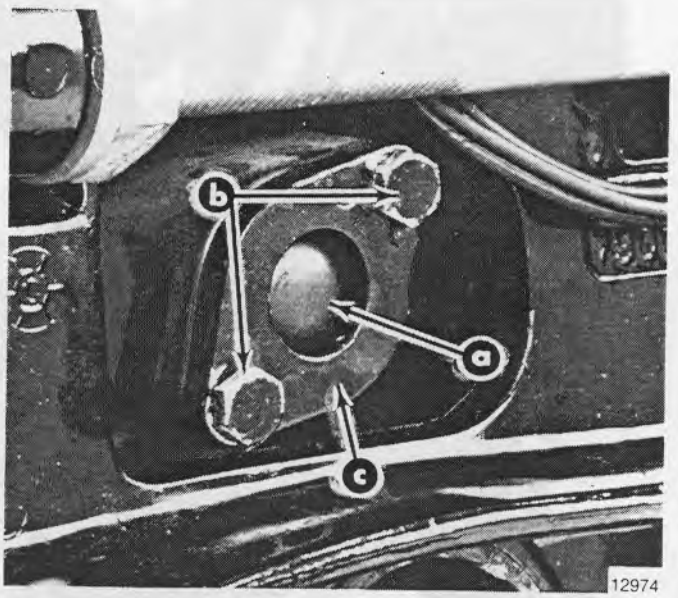
a - Water Pickup Tube
b - Cover (Retain)
c - Bolts (Discard)

Figure 3. Removing Water Pickup Tube

8. Disconnect water pickup hose from water pickup tube (on outside of gimbal housing). Remove (and discard) pickup tube and rubber grommet. Bend tube; if necessary, to aid in removal.
9. Cut water pickup hose (disconnected in last step) with a side cutter as close to bell housing connection as possible. (Figure 4)
10. Coat outer surface of rubber grommet (supplied in kit) with 2-4-C Multi-Lube and install (hollow end first) in hole from which pickup tube was removed. Secure rubber grommet with cover (retained in Step 7) and screws (10-53556) from kit. (Figure 5) Torque screws to 48 lbs. in. (5.4 N.m).

a - Water Pickup Hose
b - Side Cutters
c - Bell Housing
d - Gimbal Housing

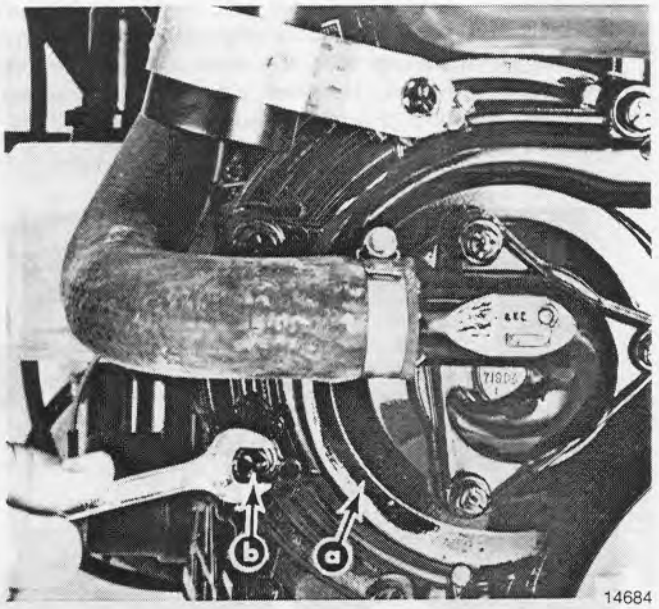
Figure 4. Cutting Water Pickup Hose



a - Rubber Grommet b - Bolts (1/4" - 20x1") c - Cover (Original)

Figure 5. Installing Rubber Grommet

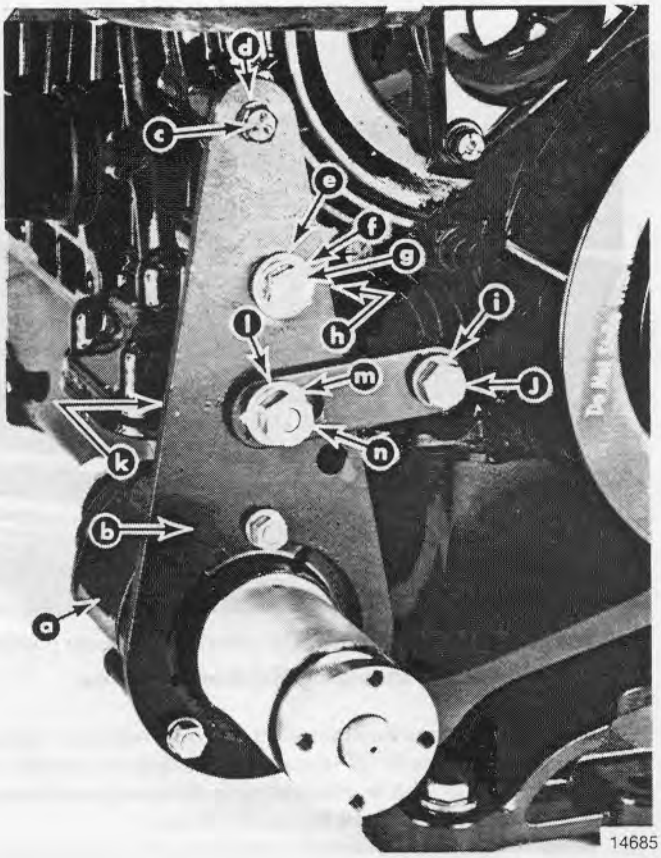
11. Install seawater pickup pump bracket onto seawater pickup pump using three 5/16" nuts and lockwashers (from kit). Install bracket with top mounting hole boss toward pump body. Torque nuts to 18 lbs. ft. (24 N.m).
12. Remove (and discard) screw from engine circulating pump impeller cover, as shown in Figure 6.



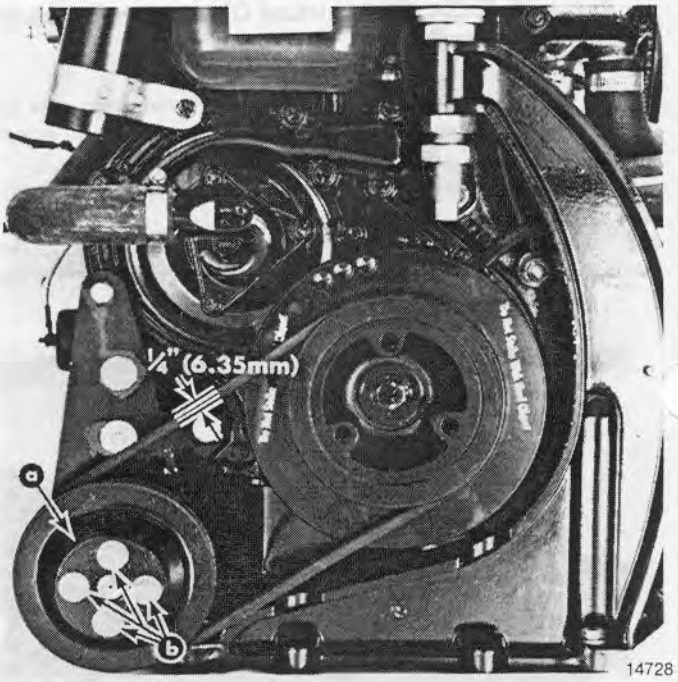
a - Impeller Cover
b - Remove (and discard) this Screw

Figure 6. Removing Engine Impeller Cover Screw

13. Install seawater pickup pump and bracket assembly on engine using screw (10-89318) and lockwasher (from kit). Screw is installed thru top mounting bracket hole that was removed in Step 12. Do not tighten screw at this time. (Figure 7)



14. Install screw (10-95961), lockwasher and flat washer (from kit) thru slotted adjustment hole in seawater pickup pump bracket and thru 1¾" (440mm) long spacer (from kit) into engine, as shown in Figure 7. Install lockwasher between screw head and flat washer as shown. Do not tighten screw at this time.
15. Install pump adjusting brace (from kit) onto engine using screw (10-60179) and lockwasher (from kit), as shown in Figure 7. Do not tighten screw at this time.
16. Install screw (10-47461) (from kit) thru seawater pump bracket and pump adjusting brace slot. Place flat washer and lockwasher onto screw; then, thread 7/16" - 14 nut (from kit) onto screw, as shown in Figure 7. Do not tighten nut at this time.
17. Install pulley (from kit) onto seawater pickup pump, using four screws (10-26065), flat washers and lockwashers (from kit), as shown in Figure 8. Torque screws to 18 lbs. ft. (24 N.m).



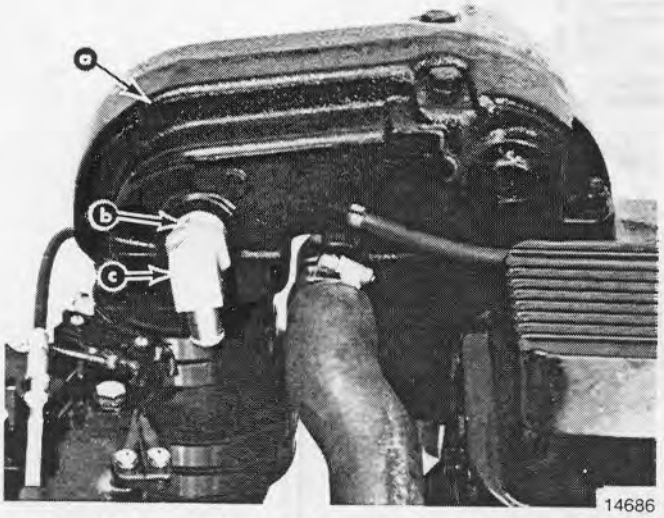
a - Pulley
b - Screws (10-26065) Lockwashers and Flat Washers (1/16" THK)

Figure 8. Installing Pump Pulley and Drive Belt

a - Seawater Pickup Pump
b - Pump Bracket
c - Screw (10-89318)
d - Lockwasher
e - Flat Washer (3/32" THK)
f - Lockwasher
g - Screw (10-95961)
h - Spacer (Hidden)
i - Lockwasher
j - Screw (10-60179)
k - Screw (10-47461) (Hidden)
l - Flat Washer (3/32" THK)
m - Lockwasher
n - Nut

Figure 7. Seawater Pickup Pump Installed

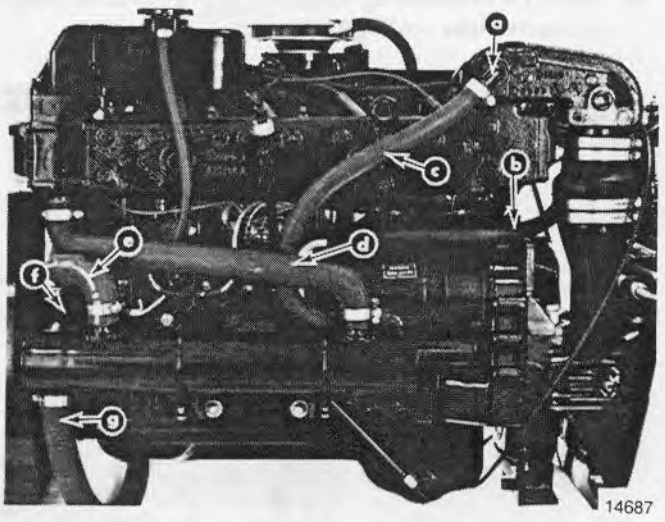
18. Install seawater pickup pump drive belt (from kit) and adjust tension, as follows:
    a. Pivot pump and mounting bracket assembly away from crankshaft pulley, as required, until upper strand of belt can be depressed ¼" (6mm) with thumb at a point midway between pulleys. (Figure 8)
    b. Torque nut (item "n" in Figure 7), which secures adjusting brace to engine, to 50 lbs. ft. (68 N.m).
    c. Torque screw (item "j" in Figure 7), which secures adjusting brace to engine, to 50 lbs. ft. (68 N.m).
    d. Torque screw (item "g" in Figure 7), which secures pump bracket and spacer to engine, to 50 lbs. ft. (68 N.m)
    e. Torque screw (item "c" in Figure 7), which secures pump bracket to engine impeller cover, to 18 lbs. ft. (24 N.m).
19. Remove (and discard) plug from outside of exhaust elbow (directly above exhaust manifold).
20. Remove 90° elbow from inside of exhaust elbow. Coat elbow threads with Perfect Seal and reinstall into hole from which plug was removed in Step 19. (Figure 10).
21. Coat threads of reducer bushing (from kit) with Perfect Seal and install into exhaust elbow hole from which 90° elbow was removed in Step 20. (Figure 9)
22. Coat threads of 90° hose connector (from kit) with Perfect Seal and install into reducer bushing, as shown in Figure 9.



a - Exhaust Elbow b - Reducer Bushing c - 90° Hose Connector

Figure 9. Reducer Bushing and 90° Connector Installed

23. Install heat exchanger (from kit) onto mounting brackets, using "U" bolts, clamping straps and elastic stop nuts (retained in Step 5), as shown; in Figure 10. Tighten elastic stop nuts securely, but DO NOT overtighten, as damage to heat exchanger could occur.
24. Connect voltage regulator hose, which was disconnected from water tube, to 90° hose connector (installed in Step 22). Secure with a hose clamp, retained in Step 6. (Figure 10)
25. Connect voltage regulator hose, which was disconnected from heat exchanger in Step 4, to small front connector of new heat exchanger, as shown in Figure 10. Secure with a hose clamp, retained in Step 4.
26. Install "L" shaped molded hose (from kit) from 90° connector at rear of heat exchanger to 90° elbow on outer side of exhaust elbow, as shown in Figure 10. Large diameter end of hose connects to heat exchanger. Secure hose with hose clamps, retained in Step 2.
27. Connect short molded hose (disconnected from heat exchanger in Step 4) to front top heat exchanger connector as shown in Figure 10. Secure hose with a hose clamp, retained in Step 4.
28. Install long, molded hose (from kit) from rear connector of heat exhanger to outer connector of thermostat housing, as shown in Figure 10. Secure hose with hose clamps, retained in step 3.



a - 90° Elbow (Original)
b - Hose, Voltage Regulator to 90° Connector
c - Hose, Heat Exchanger to 90° Elbow (from Kit)
d - Hose, Heat Exchanger to Thermostat Housing (from Kit)
e - Hose, Heat Exchanger to Thermostat Housing (Oringinal
f - Hose, Voltage Regulator to Heat Exchanger (Original)
g - Reinforced Hose, Heat Exchanger to Seawater Pickup Pump (from Kit)

Figure 10. Heat Exchanger and Hoses Installed

29. Install 40" reinforced hose (from kit) to front, bottom heat exchanger connector. Route hose under engine and connect opposite end to seawater pump outlet. Secure hose with hose clamps, from kit. (Figure 10)
30. Install 48" reinforced hose (from kit) to seawater pickup pump inlet. Secure hose with clamp, from kit. Connect other end of hose to seawater pickup, with hose clamp, from kit.
31. Fill cooling system as outlined.
32. Check engine operating temperature.

AUXILIARY HOT WATER HEATER INSTALLATION

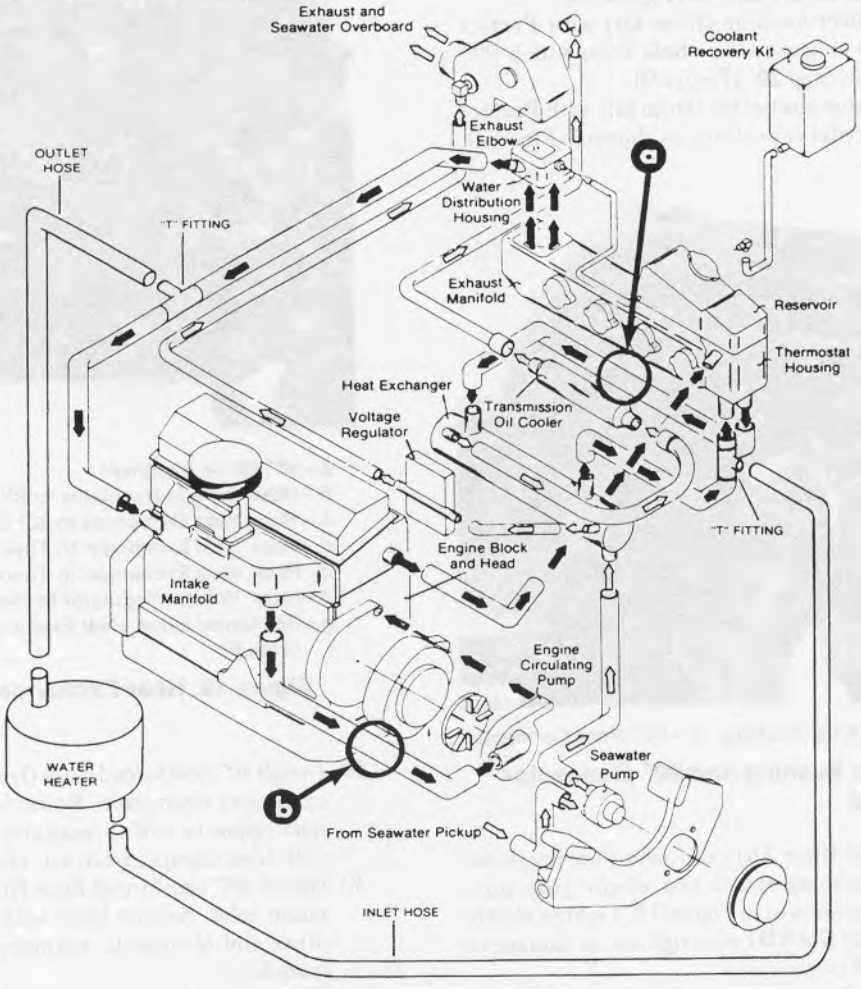
When connecting a cabin heater or hot water heater to a MerCruiser engine, certain requirements must be met.

- Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED ⅝" (16mm) I.D.
- Heater MUST BE LOWER than the fill cap on the reservoir. If the heater is higher than the fill cap on the reservoir and some coolant is lost in the system, an air pocket may form in the closed cooling system. This, in turn, can cause the engine to overheat.
- Make heater connections to MerCruiser engines ONLY AT LOCATIONS SHOWN.
- Check complete system for leaks after heater is connected into cooling system.
- Check for overheating condition (of engine) after heater is connected into cooling system.

1. Connect auxiliary hot water heater into cooling system with "T" fittings and hose clamps (provided with kit), as shown in Figures 1, 2, 3 or 4. Cut approximately ¾" (19mm) out of hoses to maintain proper hose configuration.
2. Support hoses, as required, to ensure that they do not rub or chafe against engine components.
3. Start engine and check for leaks.

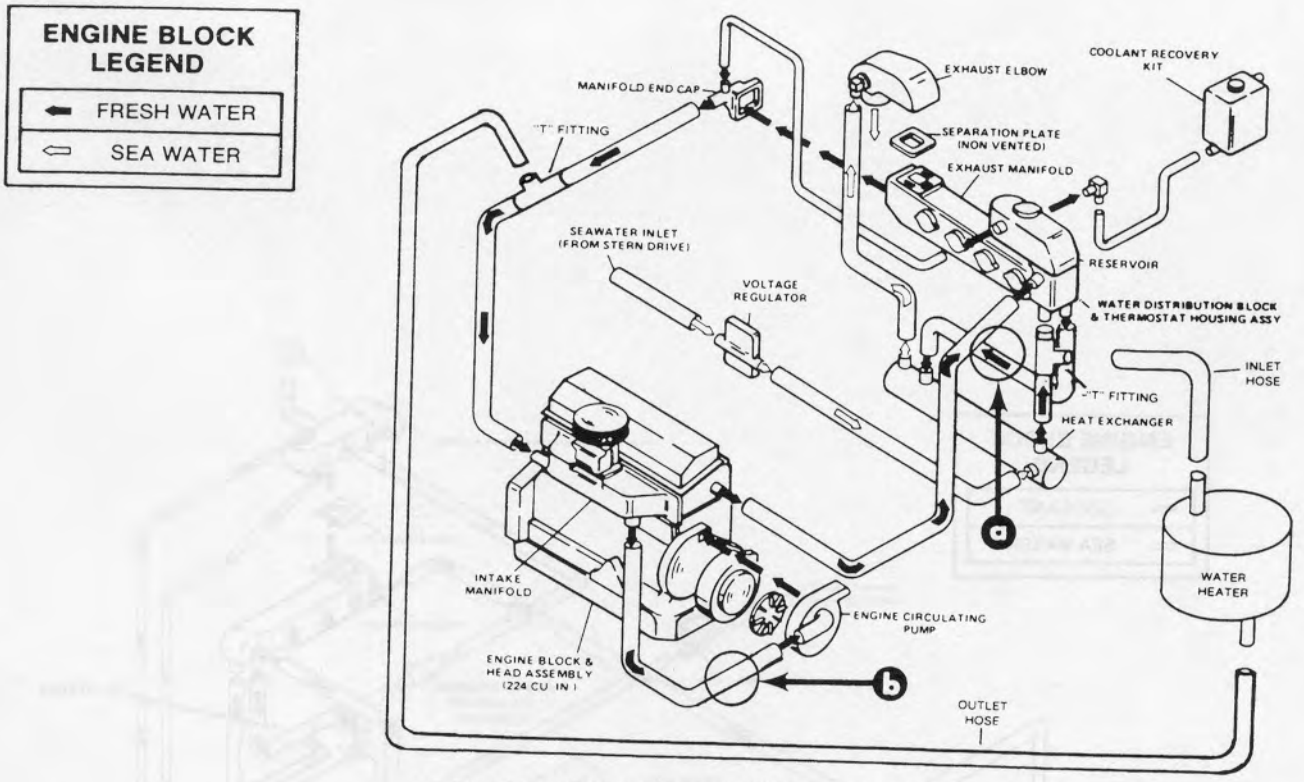
⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump or pump impeller will be damaged, and subsequent overheating damage may result.



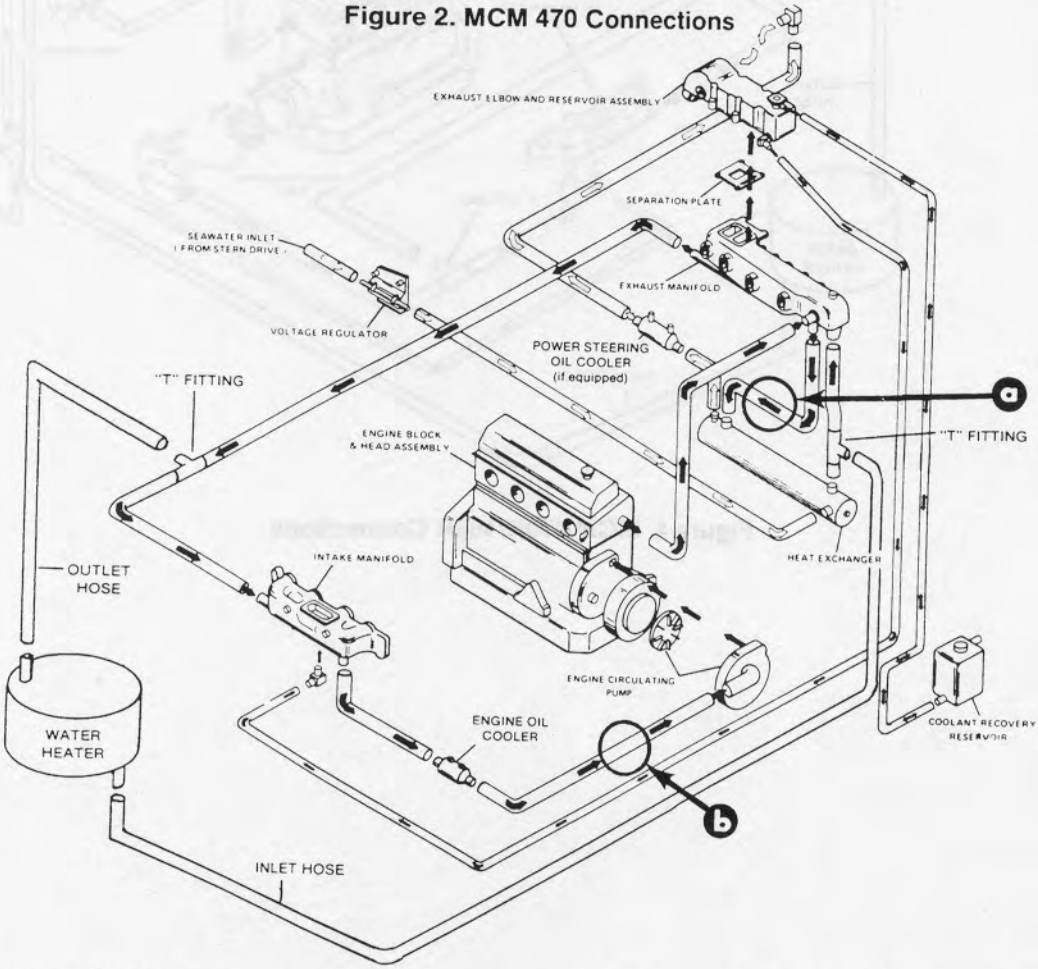
a - Install Inlet Hose Fitting Here if More Heat is Needed
b - Install Outlet Hose Fitting Here if More Heat is Needed

Figure 1. MIE 470 Connections



a - Install Inlet Hose Fitting Here if More Heat is Needed
b - Install Outlet Hose Fitting Here if More Heat is Needed

Figure 2. MCM 470 Connections



a - Install Inlet Hose Fitting Here if More Heat is Needed

b - Install Outlet Hose Fitting Here if More Heat is Needed

Figure 3. MCM 485 Connections

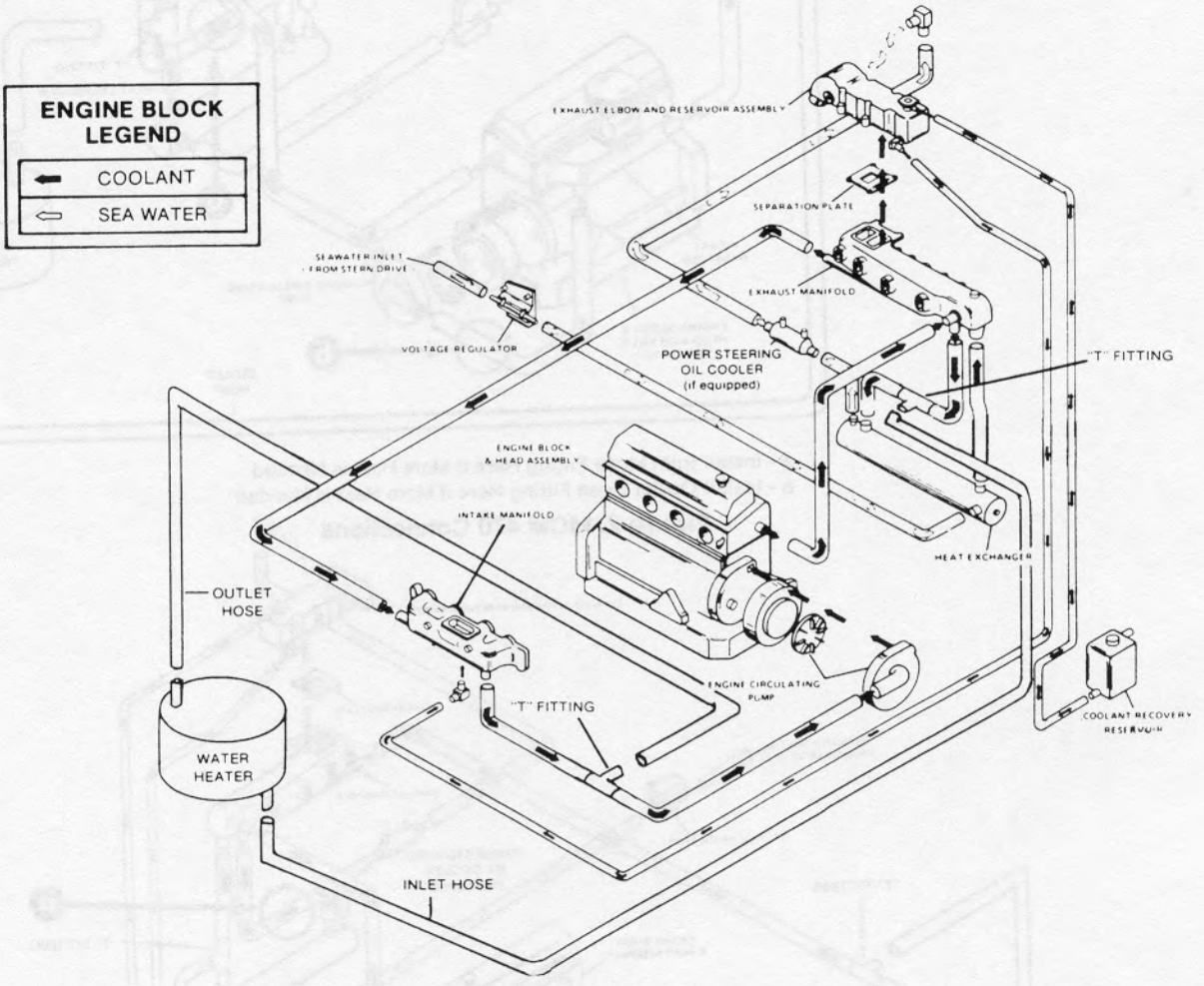
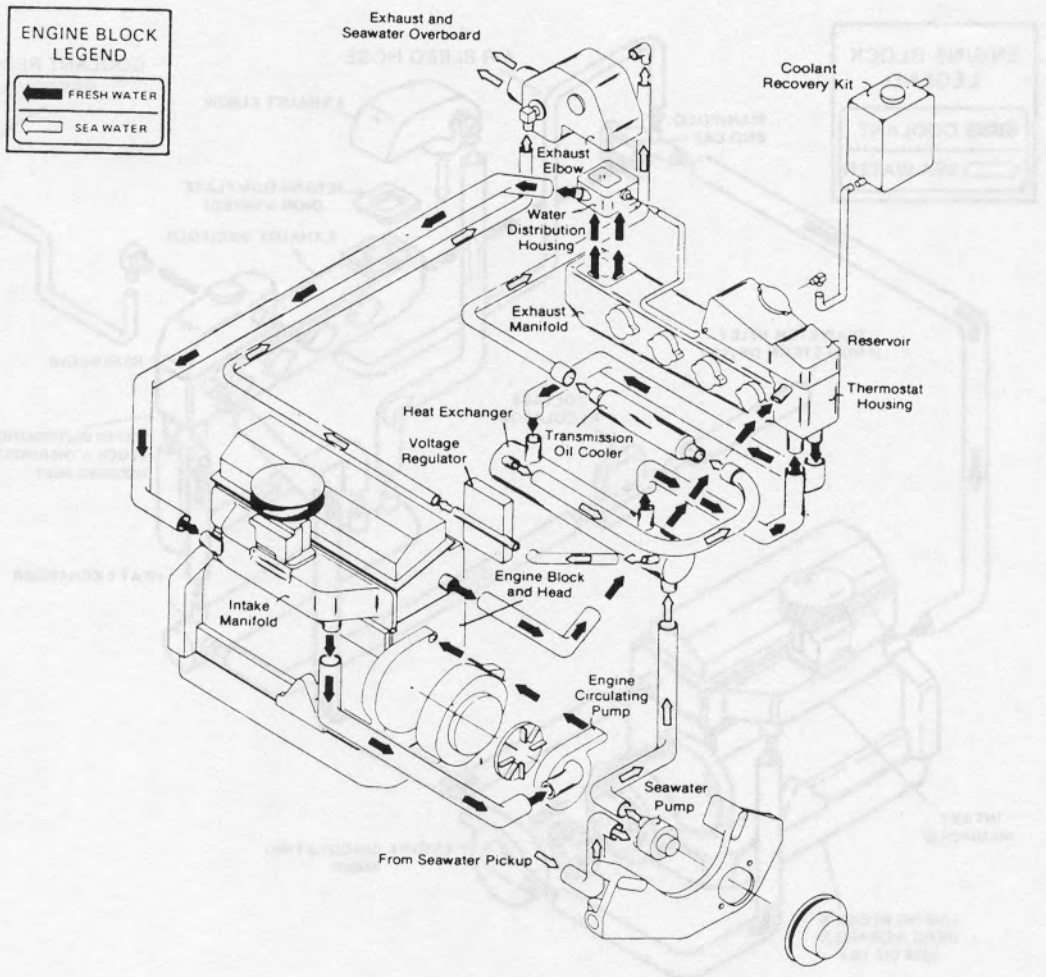
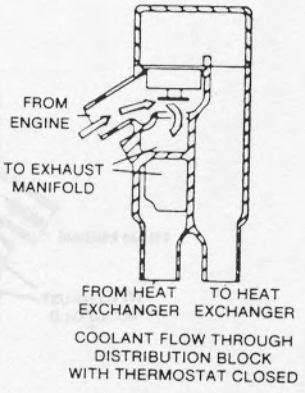


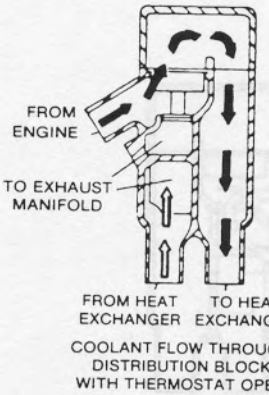
Figure 4. MCM 470R/488R Connections

COOLING SYSTEM FLOW DIAGRAMS



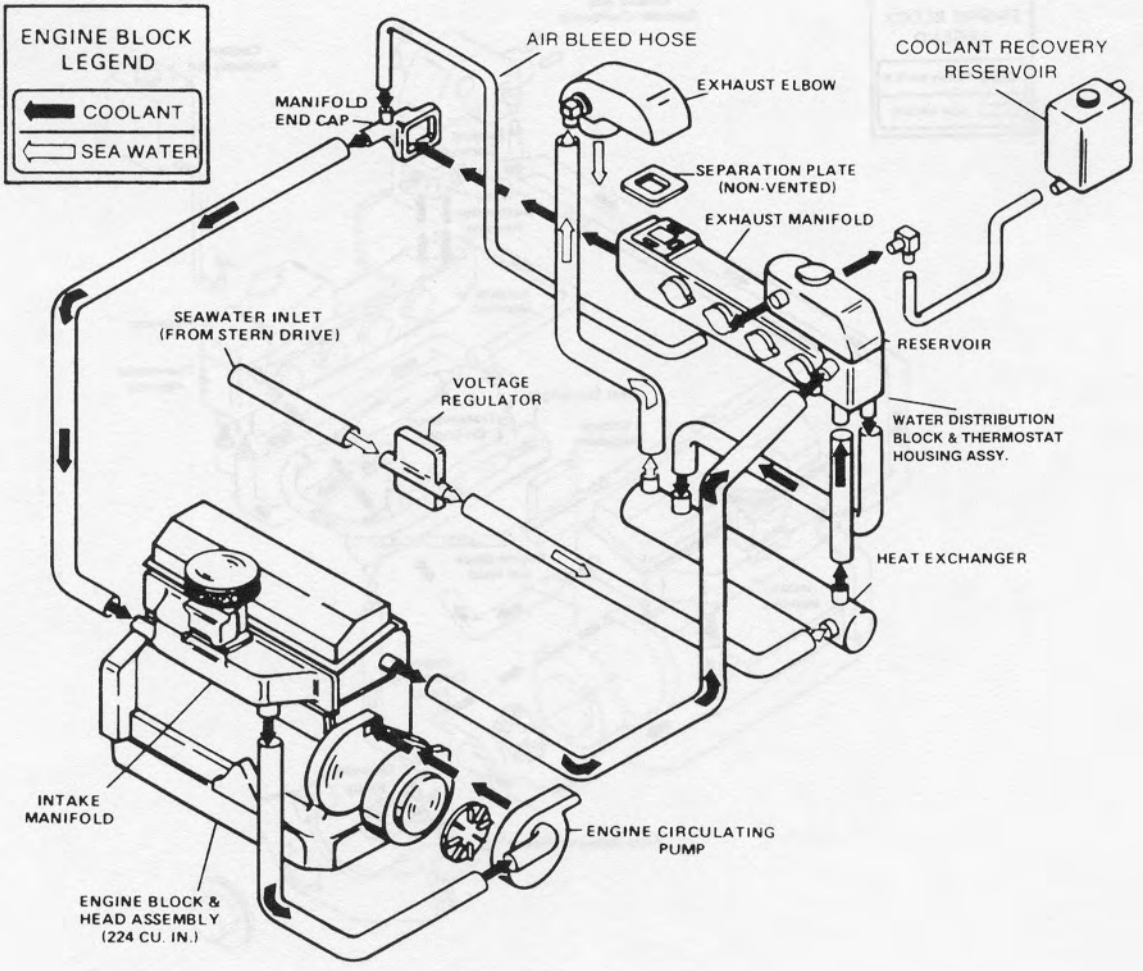


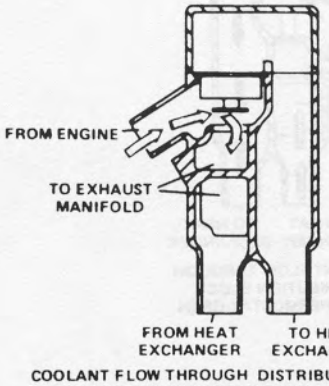
COOLANT FLOW THROUGH DISTRIBUTION BLOCK WITH THERMOSTAT CLOSED



COOLANT FLOW THROUGH DISTRIBUTION BLOCK WITH THERMOSTAT OPEN

MIE 470





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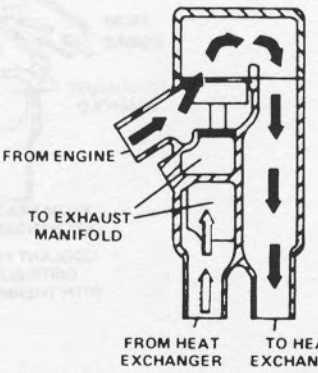
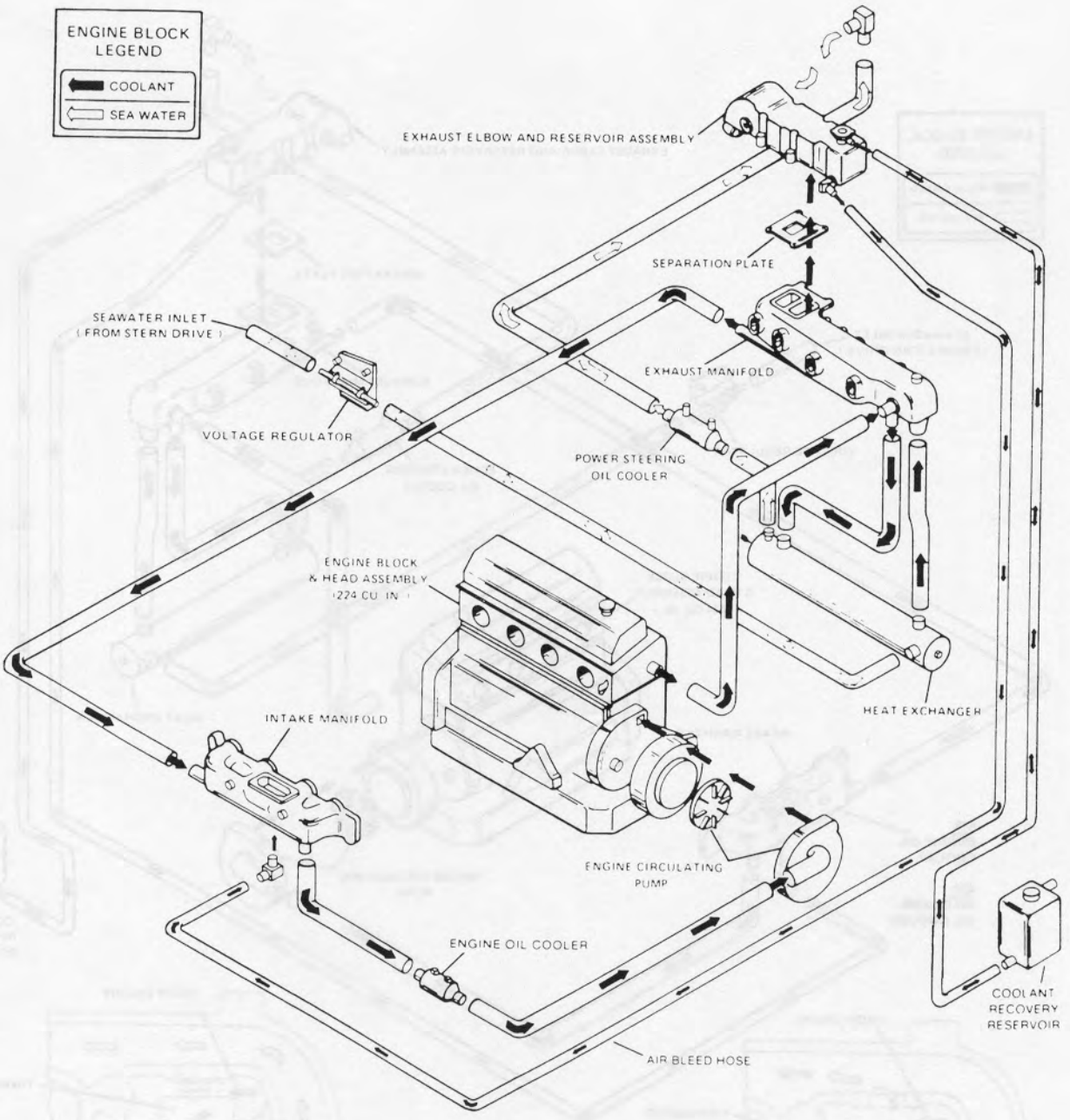
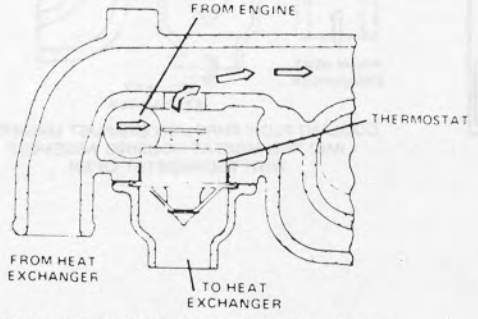


COOLANT FLOW THROUGH DISTRIBUTION BLOCK WITH THERMOSTAT OPEN

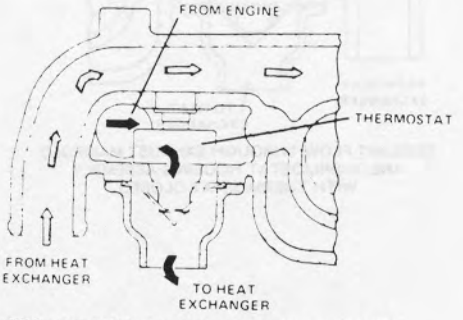
MCM 470



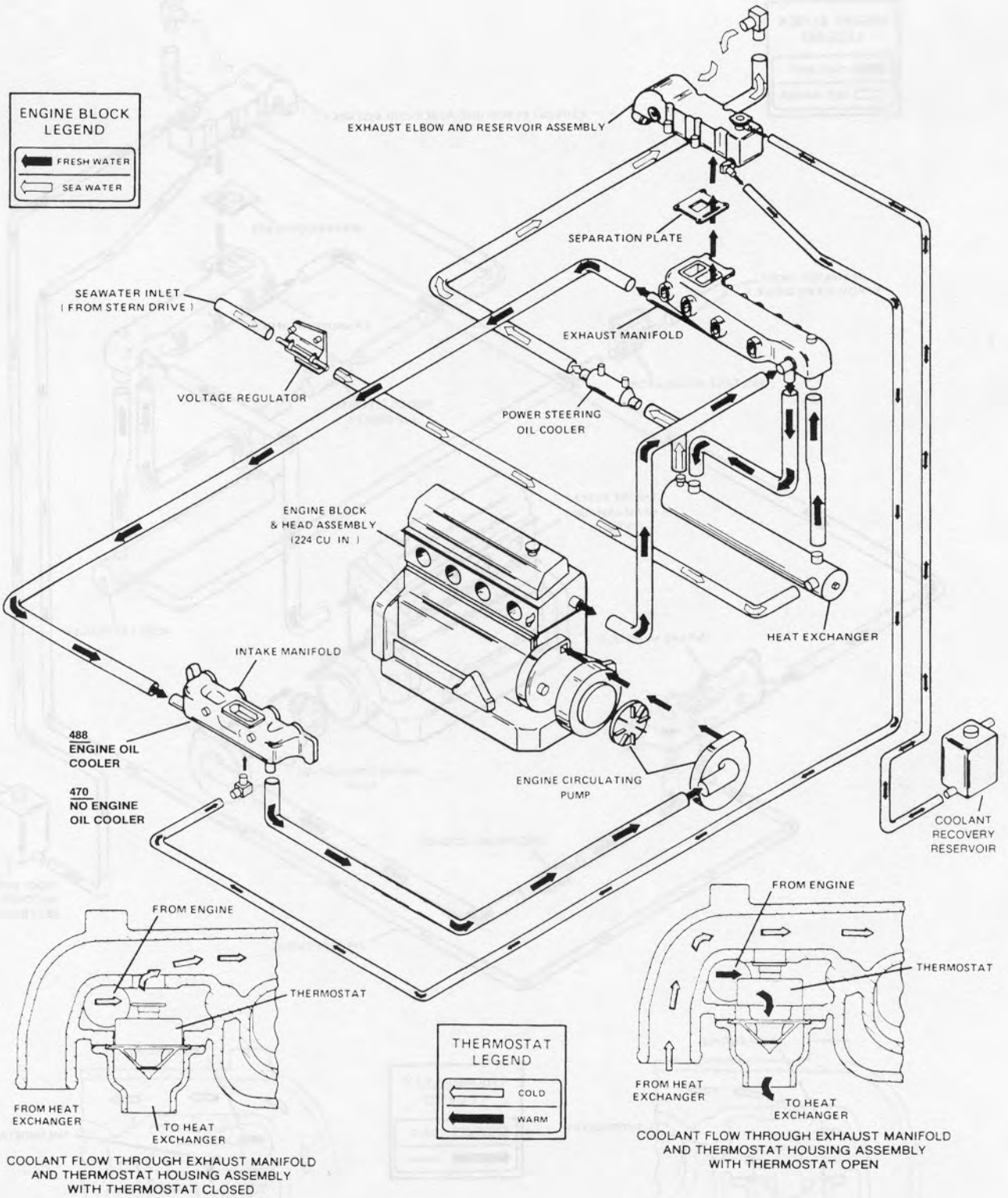


COOLANT FLOW THROUGH EXHAUST MANIFOLD AND THERMOSTAT HOUSING ASSEMBLY WITH THERMOSTAT CLOSED

MCM 485



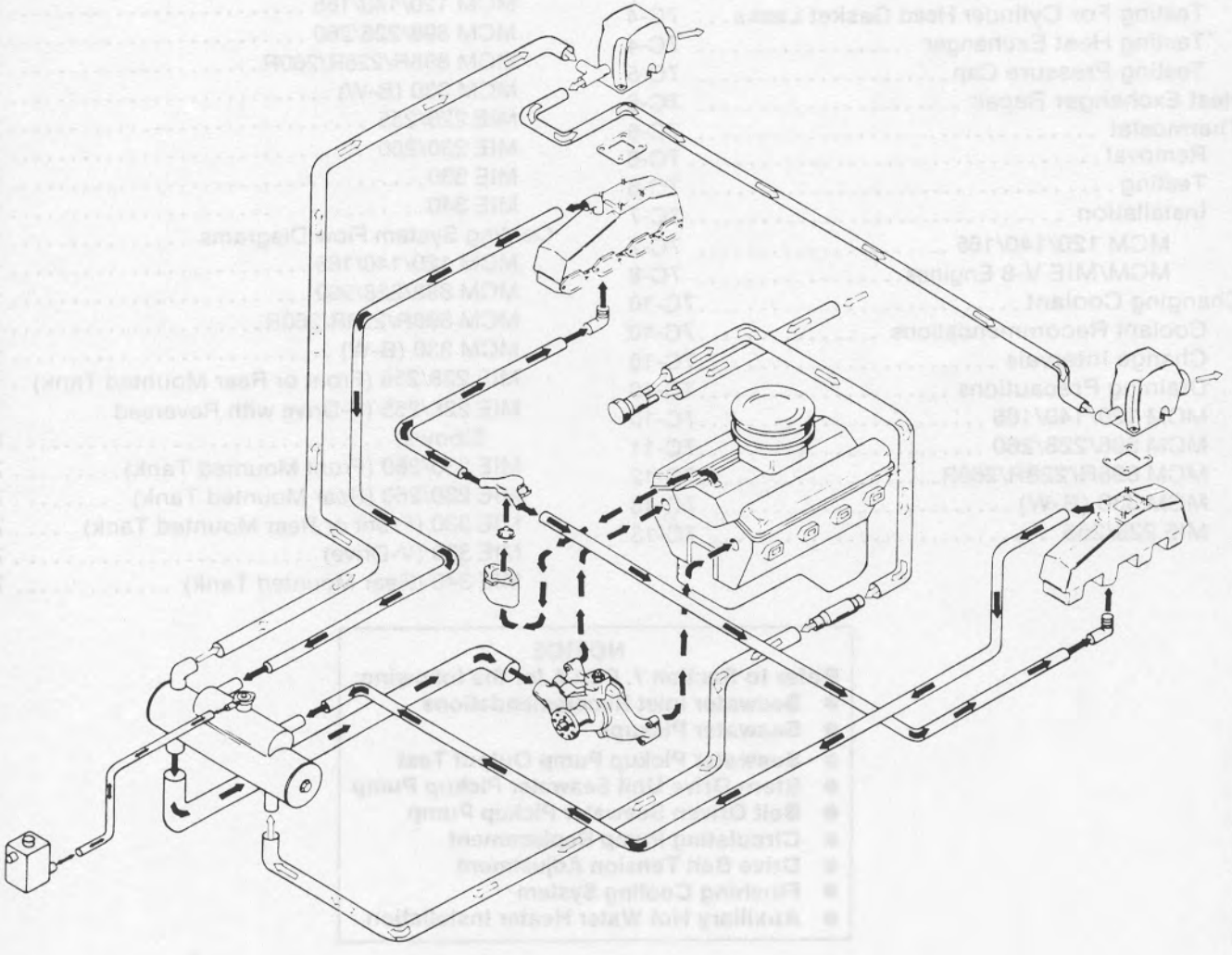
COOLANT FLOW THROUGH EXHAUST MANIFOLD AND THERMOSTAT HOUSING ASSEMBLY WITH THERMOSTAT OPEN



MCM 470R/488R

SECTION 7 - COOLING SYSTEM

PART C - CLOSED COOLED MODELS



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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NOTICE

Refer to Section 7, Part A for the following:

- **Seawater Inlet Recommendations**
- **Seawater Pickups**
- **Seawater Pickup Pump Output Test**
- **Stern Drive Unit Seawater Pickup Pump**
- **Belt Driven Seawater Pickup Pump**
- **Circulating Pump Replacement**
- **Drive Belt Tension Adjustment**
- **Flushing Cooling System**
- **Auxiliary Hot Water Heater Installation**

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Drain Plugs	Securely	
Heat Exchanger End Cap (MCM 120/140/165)		190 (22)
Heat Exchanger End Cap (V-8 Engines)		36-72 (4-8)
Heat Exchanger Mounting Brackets	Securely	
Hose Clamps	Securely	
Reservoir to Thermostat Housing (MCM 120/140/165)	30 (41)	
Thermostat Cover (120/140/165)	20 (27)	
Thermostat Cover (V-8 Engines)	30 (41)	

LUBRICANTS/SEALANTS

LUBRICANTS/SEALANTS	
92-86154A1	Quicksilver 2-4-C Mult-Lube
92-34227--1	Quicksilver Perfect Seal

SPECIFICATIONS

CLOSED COOLING SYSTEM CAPACITY	
Model	**Qts (litres) Approximately**
MCM 120/140	9 (8.5)
MCM 165	11 (10.4)
MCM 898/228/260	20 (19)
MCM 330 (B-W)	28 (26.5)
MIE 228/255	20 (19)
MIE 230/260	20 (19)
MIE 330/340	28 (26.5)

THERMOSTAT	
All Models	143° F (62° C)

PRESSURE CAP	
All Models	14 PSI (97 kPa)

DESCRIPTION

There are several configurations of this cooling system, but the operation is essentially identical. Basically, the system is composed of two separate sub-systems; the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat (from the closed cooling system) as it passes thru the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

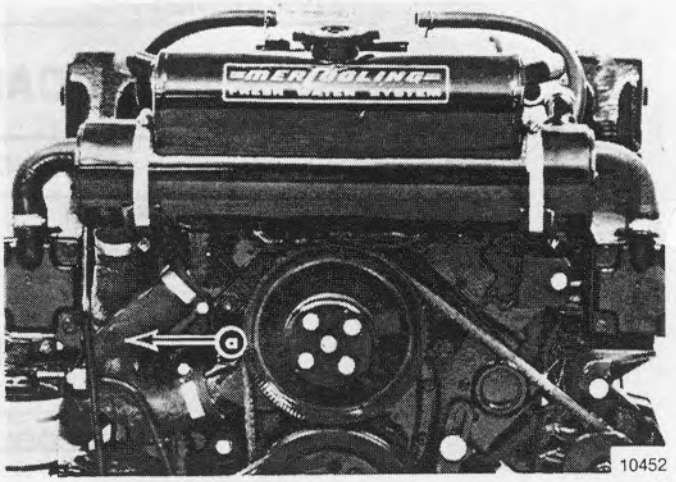
The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately ½ pint during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there's a vacuum leak, usually at the hose leaving the reservoir, or the gasket under the recovery filler cap. The gasket seals against the outer rim of the filler neck.

IMPORTANT: The coolant (anti-freeze) flows around the outside of the cooling tubes while seawater flows thru the inside of the cooling tubes in the heat exchanger.

MCM 120/140/165 exhaust manifold are seawater cooled. All V-8 engines exhaust manifold are cooled by coolant in the closed cooling system. MCM 120/140/165 engines use the stern drive seawater pickup pump to pump seawater thru the heat exchanger. All V-8 stern drive and inboard engines use a belt driven pump to pump seawater thru the heat exchanger. The seawater pickup pump in the stern drive (V-8 engines) is used to cool the stern drive only and is then dumped overboard.

CIRCULATING PUMP HOSE REPLACEMENT INFORMATION

MCM 898/228/260 (except R models) and MIE 228/255/330 models with front mounted heat exchanger use the original hose that ran from the circulating pump to the thermostat housing on seawater cooled engines. When a Closed Cooling System is installed, this hose is cut to proper length and installed between the circulating pump and heat exchanger. (Figure 1) All other models had a new hose supplied in the kit.



a - Circulating Pump Hose

Figure 1. Circulating Pump Hose

MAINTAINING COOLANT LEVEL

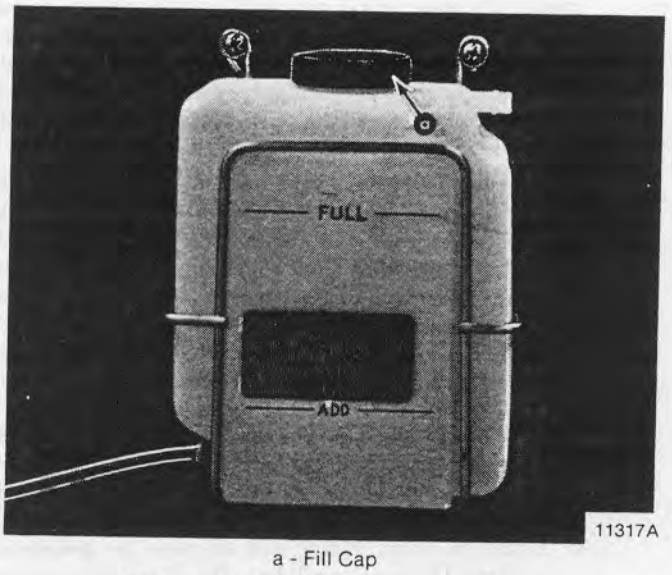
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly then, push down and turn cap all-the-way off.

1. Coolant level in heat exchanger should be within 1" (25mm) from bottom of filler neck.

   IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on filler neck.

2. Coolant level should be between the "Add" and "Full" mark on coolant recovery reservoir with engine at normal operating temperature. (Figure 1)



a - Fill Cap

Figure 1. Coolant Recovery Bottle

TESTING SYSTEM

TESTING COOLANT FOR ALKALINITY

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. If pink litmus paper turns blue, coolant is alkaline and need not be replaced.
4. If pink litmus paper remains pink, coolant is not alkaline and MUST BE REPLACED.

PRESSURE TESTING SYSTEM

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

If coolant section of Closed Cooling System is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from heat exchanger or reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined under "Testing Pressure Cap" in this section, to eliminate the possibility that cap is not maintaining proper pressure in system and is causing coolant to boil over.
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for nicks or other damage. Surface MUST BE perfectly smooth to achieve a good seal between it and rubber seal on cap. Also, check locking cams on sides of filler neck to be sure that they are not bent or damaged. If locking cams are bent or damaged, pressure cap will not hold the proper pressure.
4. Adjust coolant level in closed cooling section to 1" (25mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to 17 psi (117 kPa).
6. Observe gauge reading for approximately 2 minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining a pressure of 17 psi on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcock(s), core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing, as they usually are a sure indication of a leak.
8. Test heat exchanger, as outlined.

9. If no leakage could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following: 1) Loose cylinder head bolts or damaged gasket, 2) loose intake manifold bolts or damaged gasket (V-8 engines only), 3) loose exhaust elbow or distribution block retaining nuts or damaged gasket (V-8 engines only), 4) cracked or porous cylinder head or block, 5) cracked or porous exhaust manifold (V-8 engines only). Proceed as follows until location of internal leak is found-
   a. Start engine. Repressureize system to 17 psi and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinder(s), where leakage is taking place, sometimes can be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when plug wire is removed from leaking cylinder. Stop engine.
   b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug, that is perfectly clean or milky appearing, is a sure indication of a leak.
   c. Drain oil from engine and examine for presence of coolant. Oil usually will be milky, if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, repressurize closed cooling section to 17 psi and examine internal surfaces of engine to locate leak.
   d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

TESTING FOR CYLINDER HEAD GASKET LEAK

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor; and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures which cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (61-91cm) long hose for this test.
2. Route this hose so a "U" is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (10-13cm) of the "U".
4. Observe the "U" while the engine is running.
   a. During idle and warm-up: some coolant and/or air will leave the reservoir.
   b. During cruising speed (2500-3500 RPM); coolant and/or air leaving the reservoir should stop after approximately 5 minutes running at a given RPM. A leaking head gasket will produce air bubbling through the "U", going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the bubbles will depend on the size of the leak.
   c. At higher speeds (4000 + RPM): Normal operation is the same as described in "b" above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant

It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately 5 minutes at a given RPM. A head gasket leak will not stop - the one thing that marks a failed head gasket is the continued passage of air, that may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant continues to flow (not in violent, intermittent bursts) from the reservoir at cruising speed, something else besides the head gasket is causing the engine to overheat.

TESTING HEAT EXCHANGER

For Internal Leak: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

a. Remove a seawater hose from the exchanger. DO NOT DRAIN the exchanger.
b. Pressurize the closed cooling circuit to 14-20 PSI (97-138kPa) with a radiator tester.
c. If seawater begins to flow from the nipple there is a leak.

For Blockage:

IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flows AROUND the tubes.

a. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
b. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

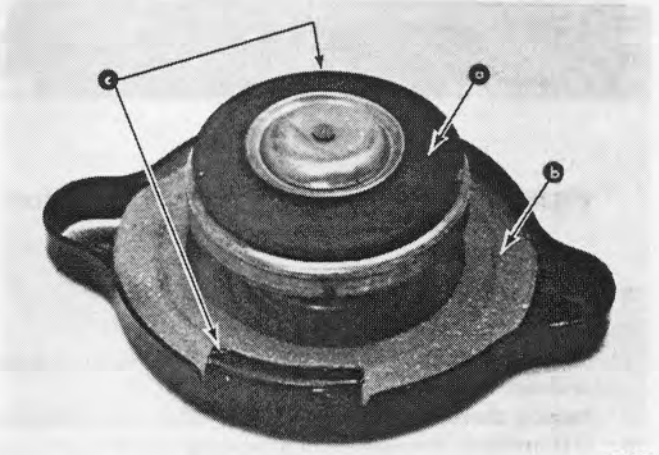
TESTING PRESSURE CAP

Pressure cap is designed to maintain a pressure of approximately 14 psi (97 kPa) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure, as follows:

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Carefully remove pressure cap from reservoir or heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. (Figure 1) Replace gasket, if damage, or entire cap, if rubber seal is damaged.



14961

a - Rubber Seal (Cap MUST BE Replaced if damaged)
b - Gasket (Look for Cracks under Gasket)
c - Locking Tabs (1 Hidden)

Figure 1. Pressure Cap

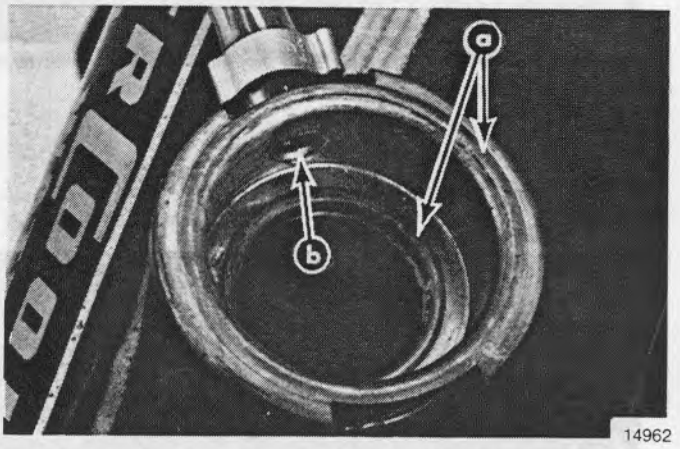
4. Check that locking tabs on cap are not bent or damaged.
5. Using a cooling system pressure tester (similar to one shown in Figure 2), test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructons which accompany tester for correct test procedure.) Cap MUST relieve pressure at 14 psi (97 kPa) and must hold rated pressure for 30 seconds without going below 11 psi. Replace cap if it fails to fall within these limits.

06054

Figure 2. Pressure Testing Pressure Cap

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent (Figure 3).

6. Reinstall cap on reservoir or heat exchanger.



14962

a - Inspect for Damage b - Clean Coolant Recovery Passage

Figure 3. Heat Exchanger

HEAT EXHANGER REPAIR

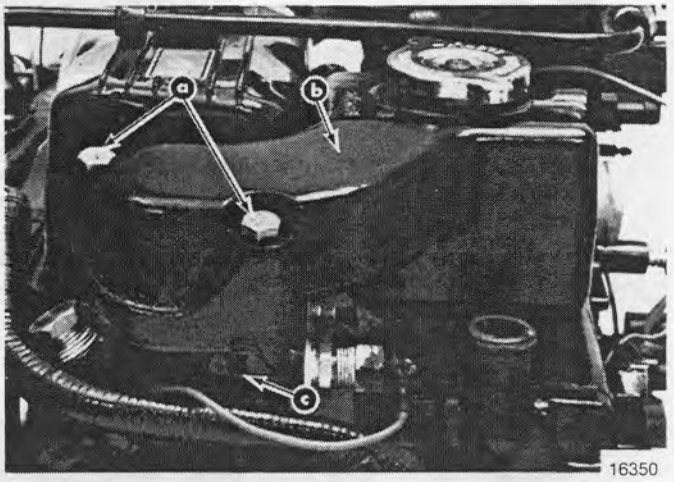
IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. DO NOT close more than 3 tubes.
2. Nipples and drains, that have been broken off the heat exchanger, can be re-attached by brazing.

THERMOSTAT

REMOVAL

1. Drain coolant from cylinder block and exhaust manifold(s).
2. Disconnect hose(s) from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket. (Figure 1, 2 or 3)
4. Remove thermostat from thermostat housing.

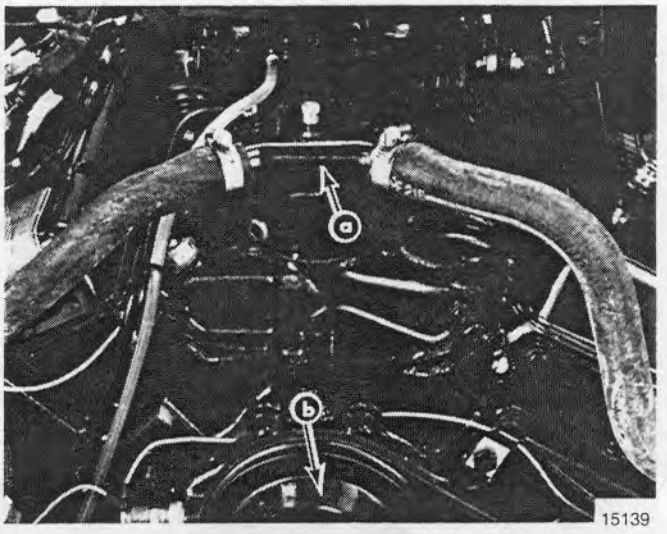


a - Bolts
b - Reservoir
c - Thermostat Housing

Figure 1. MCM 120/140/165

a - Thermostat Cover

Figure 2. MCM 898/228/260 and MIE 228/255/330

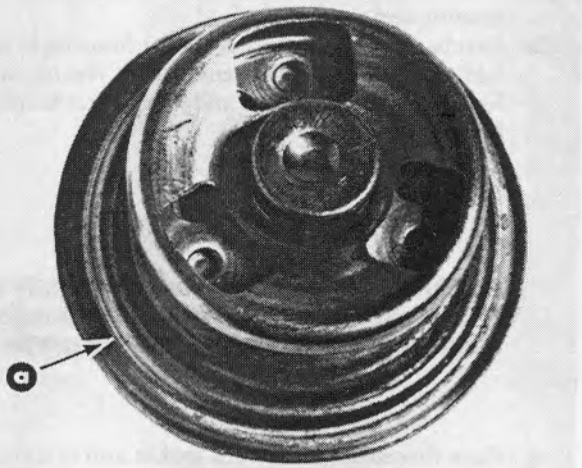


a - Thermostat Cover
b - Circulating Pump

Figure 3. MCM 898R/228R/260R/330 (B-W) and MIE 230/260/340

TESTING

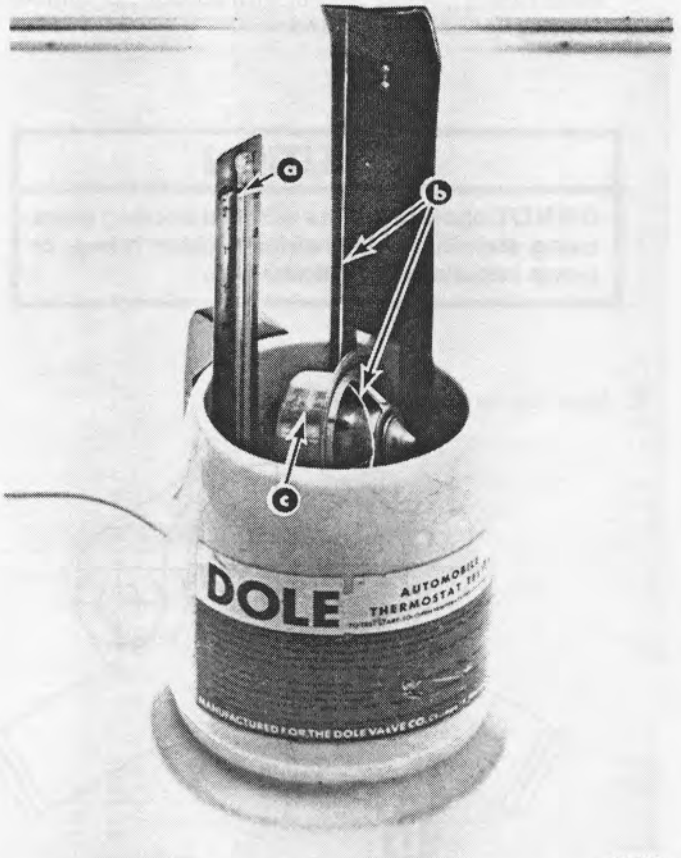
1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve (Figure 4) indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or 2 points around the valve perimeter is acceptable.)
4. Check opening and closing temperature of thermostat (using a tester similar to the one shown in Figure 5), as follows:
   a. Fill tester to within 1" (25mm) of top with tap water. DO NOT use distilled water.
   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



11363

a - Check for Light Leakage around Perimeter of Valve

Figure 4. Checking Typical Thermostats for Leakage



08788

a - Thermometer
b - Nylon String
c - Thermostat

Figure 5. Thermostat Tester

c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. DO NOT allow thermometer to touch container.

IMPORTANT: When performing Steps d and e, water MUST BE agitated thoroughly to obtain accurate results.

d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat MUST open at 138° - 145° F (59° - 63° C). Thermostat must be completely open at 170° F (77° C).
e. Unplug tester and allow water to cool to a temperature 10° F (5° C) below specified temperature on thermostat. Thermostat MUST BE completely closed at this temperature.
f. Replace a thermostat that fails to meet all of the preceding tests.

INSTALLATION

11315

a - Install Thermostat with This End toward Thermostat Housing

Figure 6. Typical Thermostat Installation

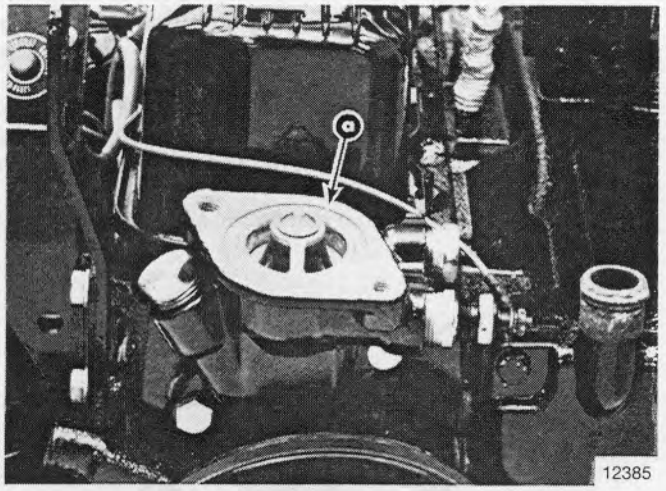
MCM 120, 140 and 165

1. Clean gasket surfaces on reservoir and thermostat housing.
2. Place thermostat in thermostat housing with thermostatic element end toward housing. (Figure 7) Be sure to positon thermostat so that mounting flange fits into recess in thermostat housing.
3. Coat both sides of new gasket with Perfect Seal and position on thermostat housing. Reinstall reservoir and torque bolts to specifications.
4. Reconnect hose to thermostat cover.
5. Refill closed cooling section as outlined in "Changing Coolant", see Index.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged.

6. Start engine and inspect for leaks.



a - Thermostat

FIGURE 7. MCM 120/140/165

MCM/MIE V-8 Engines

The thermostat housings and covers are made from the same basic castings. HOWEVER, the drilled holes, for mounting the assemblies to th intake manifold, are in different locations for the small block and large block V-8 engines. Refer to Figure 8 for correct location of mounting holes in the different assemblies.

1. Remove thermostat housing and gaskets. Discard gaskets.
2. Clean gasket surfaces on thermostat cover, thermostat housing and intake manifold.
3. Coat both sides of new thermostat housing to intake manifold gasket (WITHOUT continuity rivets), with Perfect Seal, then position gasket and thermostat housing on manifold.

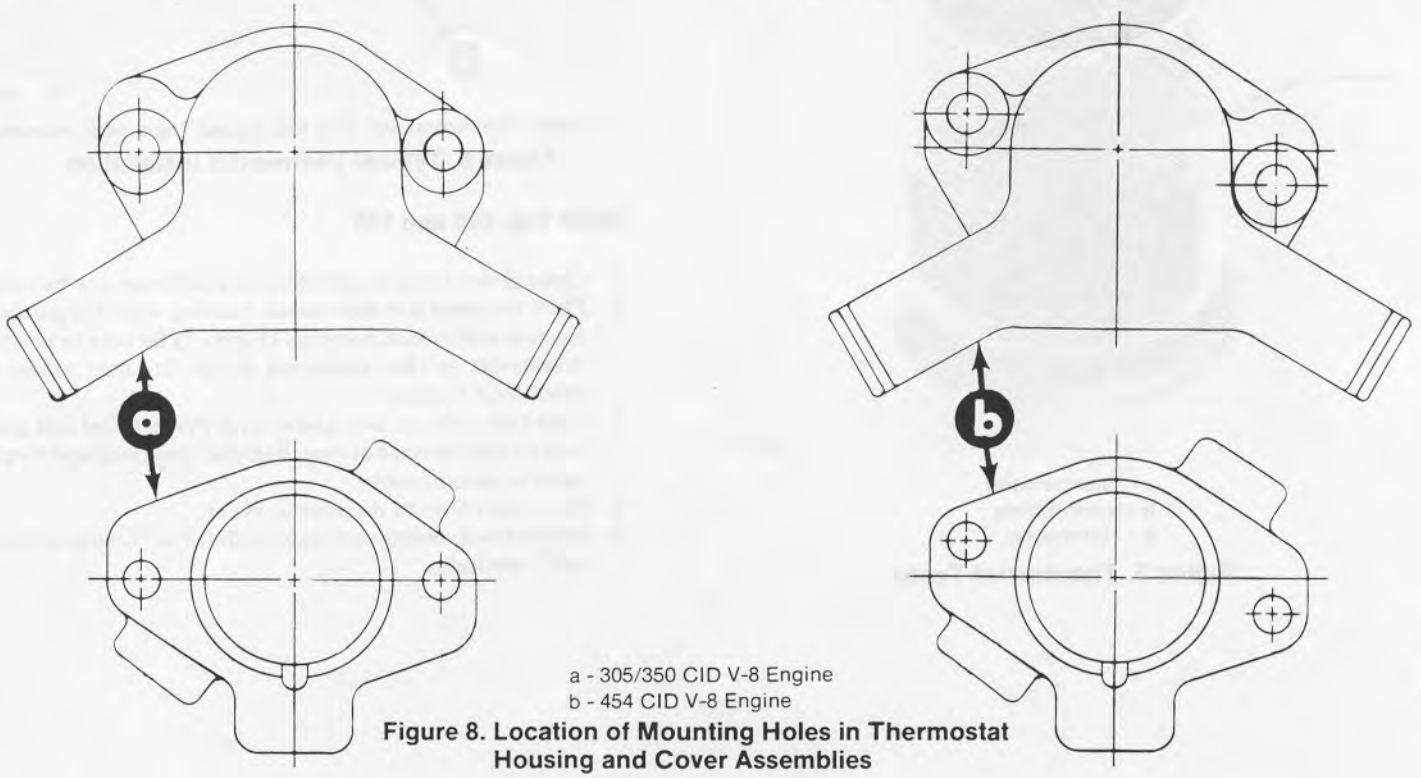
IMPORTANT: If gasket has continuity rivets, DO NOT coat with Perfect Seal or Audio Warning temperature switch may not work properly.

4. Place thermostat, new cork gasket and retaining sleeve in thermostat housing, as shown in Figure 9 or 10.
5. Coat both sides of new thermostat cover gasket with Perfect Seal, then position gasket on thermostat housing and reinstall thermostat cover. Torque bolts to specifications.
6. Reconnect hoses to thermostat cover.
7. Refill Closed Cooling System with coolant, as outlined in "Changing Coolant", see Index.

⚠CAUTION

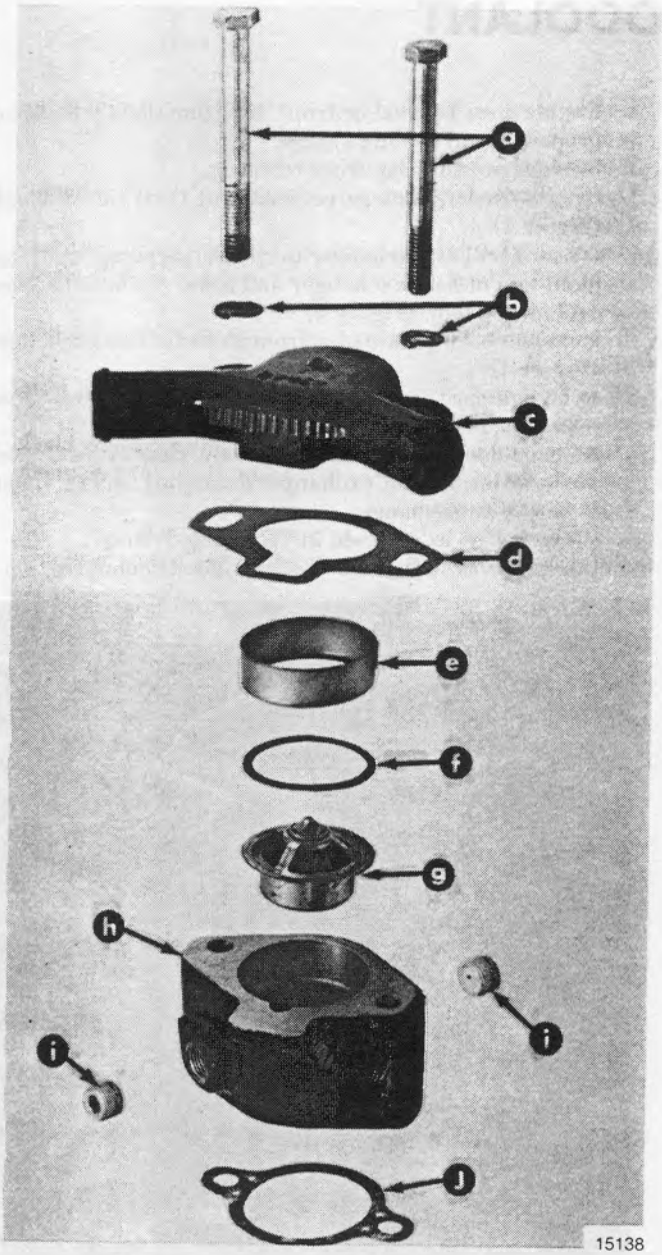
DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged.

8. Start engine and inspect for leaks.



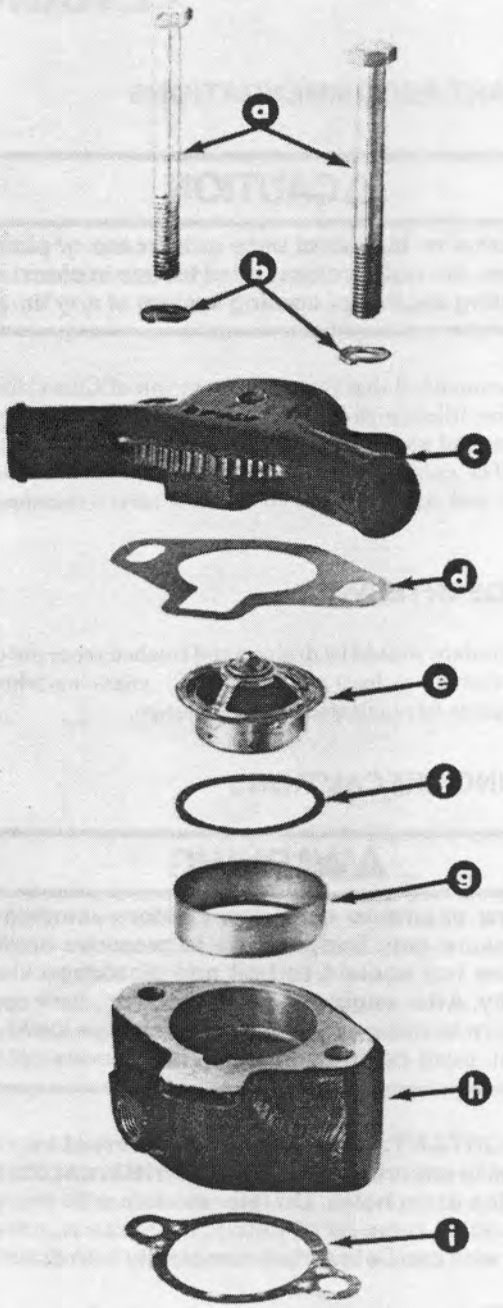
a - 305/350 CID V-8 Engine
b - 454 CID V-8 Engine

Figure 8. Location of Mounting Holes in Thermostat Housing and Cover Assemblies



a - Bolts (Torque to Specifications)
b - Lockwashers
c - Cover
d - Gasket (Coat with Perfect Seal)
e - Sleeve (Install with Turned-In Edge Down)
f - Cork Gasket (Do Not Use Perfect Seal)
g - Thermostat
h - Housing
i - Plugs
j - Gasket (Coat with Perfect Seal)

Figure 9. 305/350 CID Engines



a - Bolts (Torque to Specifications)
b - Lockwashers
c - Cover
d - Gasket (Coat with Perfect Seal)
e - Thermostat
f - Cork Gasket (Do Not Use Perfect Seal)
g - Sleeve (Turned-In Edge Up)
h - Housing
i - Gasket with Continuity Rivets (Do Not Use Perfect Seal)

Figure 10. 454 CID Engines

CHANGING COOLANT

COOLANT RECOMMENDATIONS

⚠CAUTION

Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in cloesed cooling section of cooling system at any time.

It is recommended that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturers recommendations).

CHANGE INTERVALS

The old coolant should be drained and flushed from the closed cooling system at least every two (2) years or whenever exhaust gases have entered into the system.

DRAINING PRECAUTIONS

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

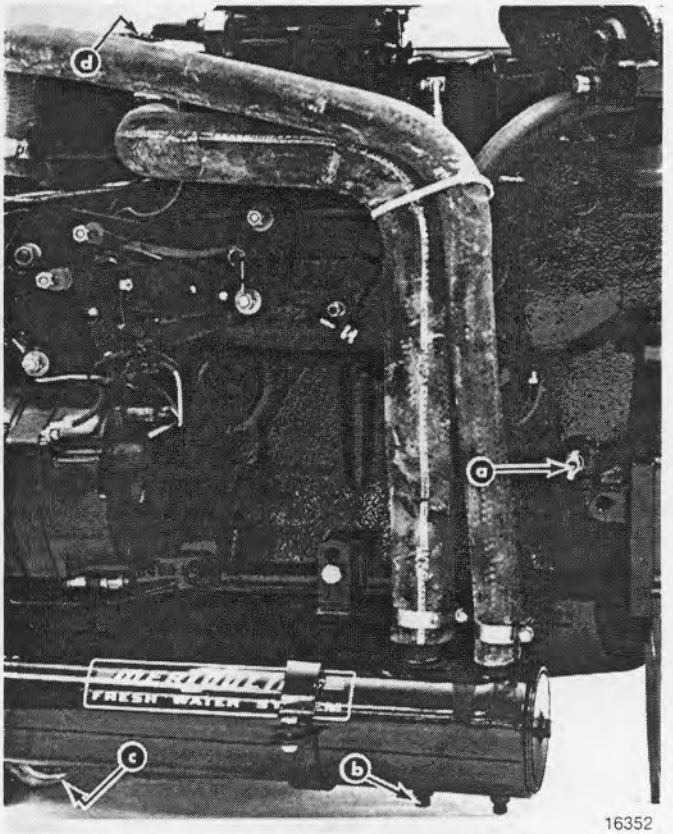
IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcocks, removal of petcock may be required so that wire can be inserted completely into drain hole.

NOTE: If possible, place a container under drains to prevent coolant from draining into boat.

MCM 120/140/165

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Open cylinder block petcock on port (left) side of block. (Figure 1)
4. Disconnect heat exchanger to circulating pump hose from front end of heat exchanger and lower the hose to allow coolant to drain. (Figure 1)
5. Remove coolant drain plug from aft end of heat exchanger. (Figure 1)
6. If so equipped, remove coolant recovery reservoir from mounting bracket and drain coolant.
7. After coolant has drained completely, close cylinder block petcock, install heat exchanger drain plug, and reconnect hose to heat exchanger.
8. Clean system as outlined in "Cleaning System".
9. Fill system as outlined in "Filling Closed Cooling Section".

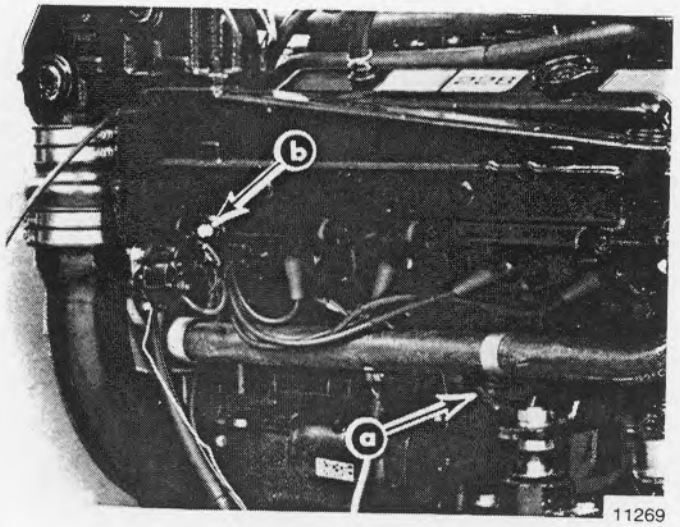


a - Petcock (1)
b - Drain Plug (1) - Coat Threads with Perfect Seal
c - Hose
d - Pressure Cap

Figure 1. MCM 120/140/165

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

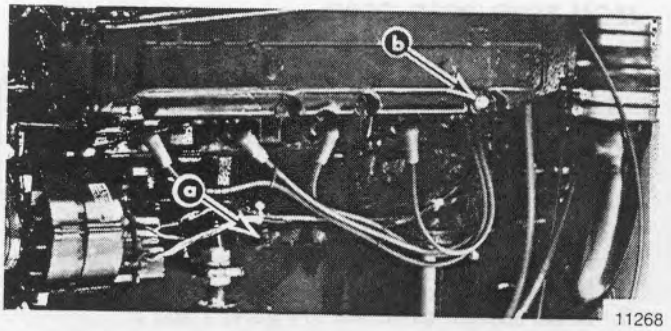
1. Engine must be level to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Remove drain plugs from port and starboard exhaust manifolds. (Figures 1 and 2)
4. Open cylinder block petcocks on each side of cylinder block. (Figures 1 and 2)
5. Remove hose from circulating pump (Figure 3) to drain remaining coolant.
6. After coolant has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close cylinder block petcocks and reinstall large hose to circulating pump.
7. Remove coolant recovery bottle from mounting bracket and pour out coolant.
8. Clean system as outlined in "Cleaning System".
9. Fill system as outlined in "Filling Closed Cooling Section.



11269

a - Petcock (1)
b - Drain Plug (1)

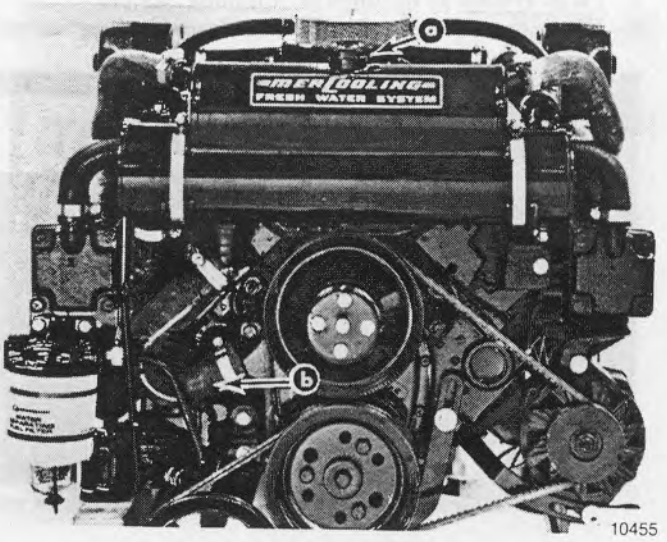
Figure 1. MCM 898/228/260 (Starboard)



11268

a - Petcock (1)
b - Drain Plug (1)

Figure 2. MCM 898/228/260 (Port)



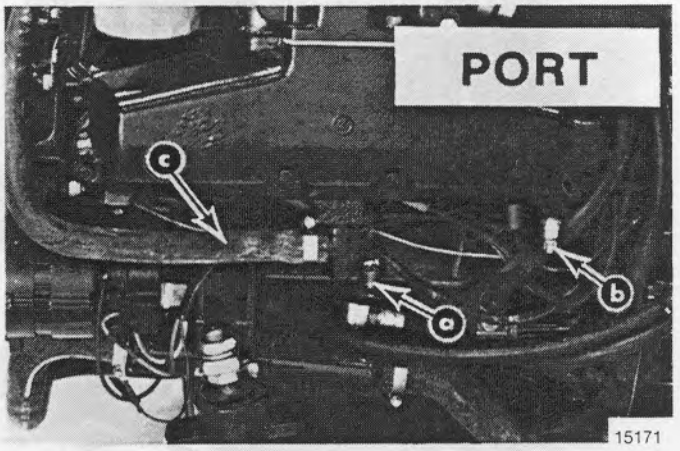
10455

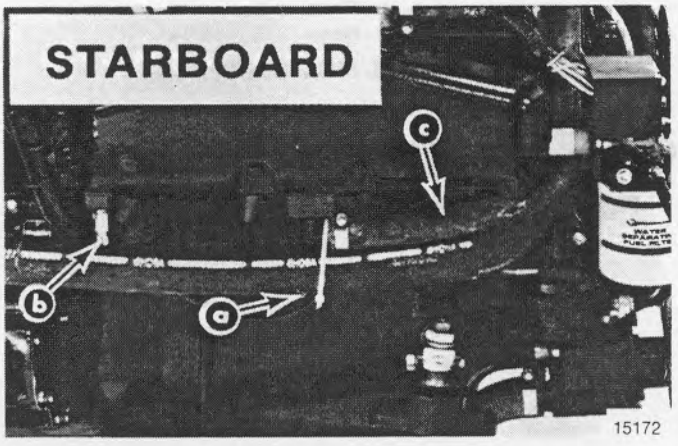
a - Pressure Cap
b - Hose

Figure 3. MCM 898/228/260

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

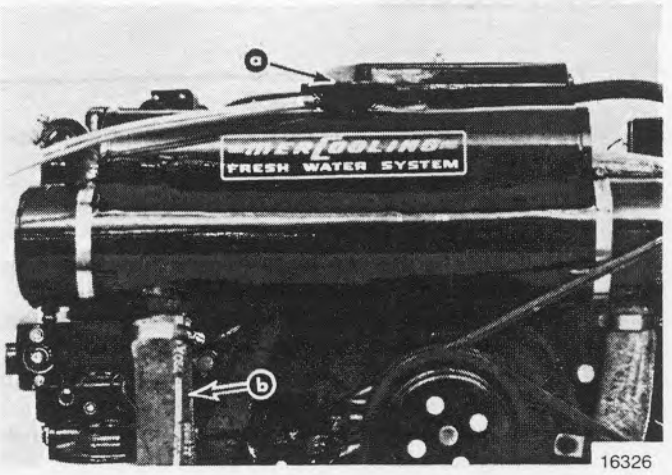
1. Engine must be level to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Drain coolant as shown in Figures 1 and 2.
4. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
5. Remove coolant recovery bottle from mounting bracket and pour out coolant.
6. Clean system as outlined in "Cleaning System".
7. Fill system as outlined in "Filling Closed Cooling Section".





a - 2 Cylinder Block Petcocks (1 Hidden)
b - 2 Exhaust Manifold Petcocks
c - Remove 2 Hoses and Lower to Drain

Figure 1. MCM 898R/228R/260R

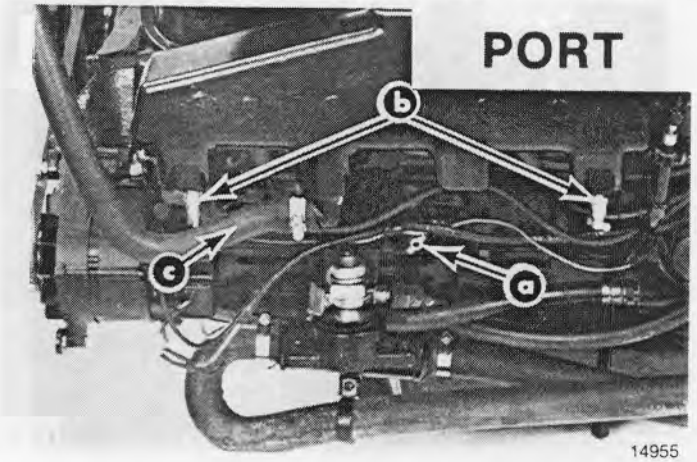


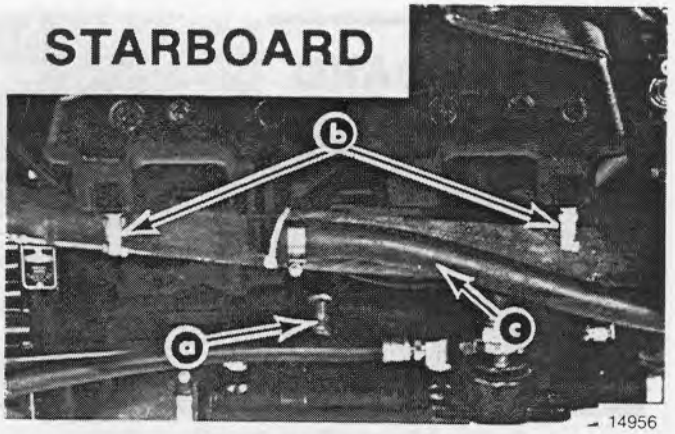
a - Remove Pressure Cap
b - Remove Hose and Lower to Drain

Figure 2. MCM 898R/228R/260R

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

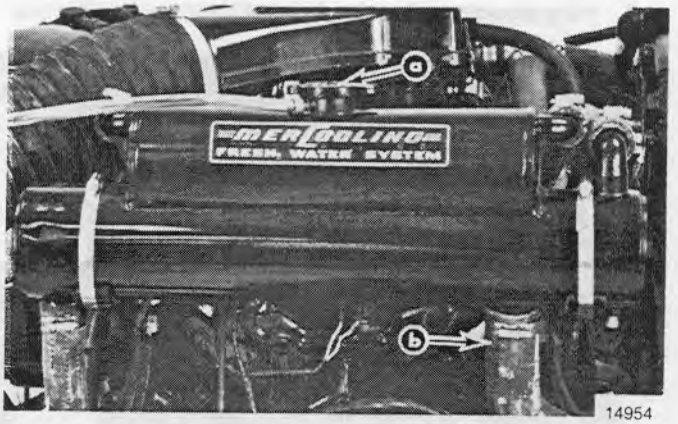
1. Engine must be level to properly drain cooling system.
2. Remove pressure cap.
3. Drain coolant as shown in Figures 1 and 2.
4. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
5. Remove coolant recovery bottle from mounting bracket and pour out coolant.
6. Clean system as outlined in "Cleaning System".
7. Fill system as outlined in "Filling Closed Cooling Section".





a - 2 Cylinder Block Petcocks
b - 4 Exhaust Manifold Petcocks
c - Remove 2 Hoses and Lower to Drain

Figure 1. MCM 330 (B-W)



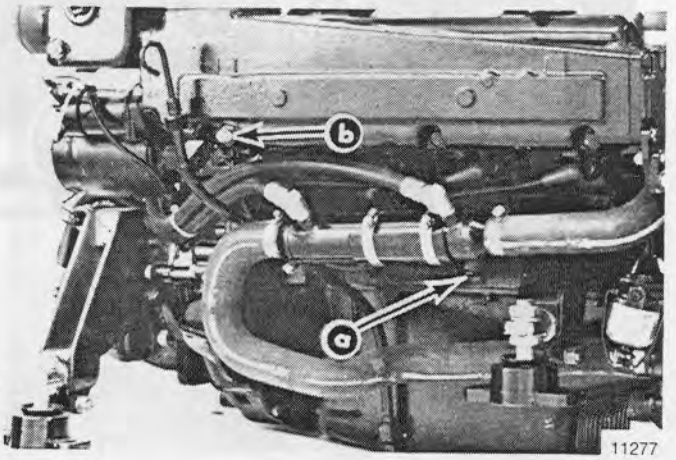
a - Remove Pressure Cap
b - Remove Hose and Lower to Drain

Figure 2. MCM 330 (B-W)

MIE 228/255

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

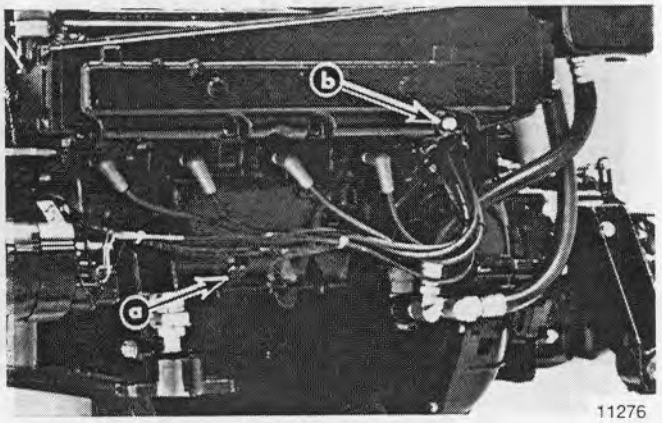
1. Engine must be level to properly drain cooling system.
2. Remove pressure cap from heat exchanger reservoir.
3. Remove drain plugs from port and starboard exhaust manifolds and open cylinder block petcocks on each side of block. (Figures 1 and 2)
4. • **On engines with front-mounted Closed Cooling:** Disconnect heat exchanger to circulating pump hose from circulating pump and bend hose to allow coolant to drain. (Figure 3)
5. • **On engines with rear-mounted Closed Cooling:** Disconnect heat exchanger to circulating pump hose from heat exchanger and lower hose to allow coolant to drain from pump and hose. (Figure 4)
6. Remove coolant recovery reservoir from mounting bracket and pour out coolant.
7. After coolant has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close cylinder block petcocks and reconnect hose to circulating pump or heat exchanger.
8. Clean system as outlined in "Cleaning System".



a - Petcock (1)
b - Drain Plug (1)

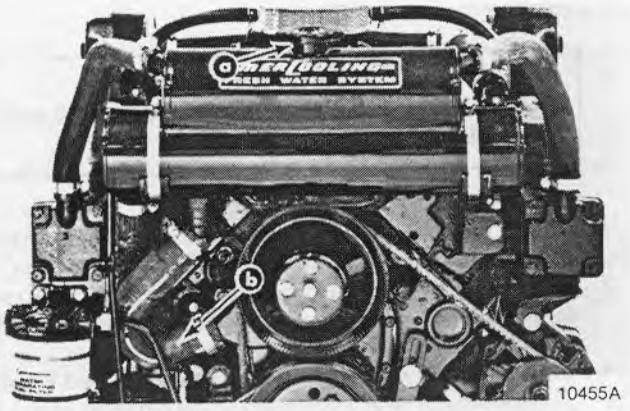
Figure 1. MIE 228/255 (Starboard)

9. Fill system as outlined in "Filling Closed Cooling Section".



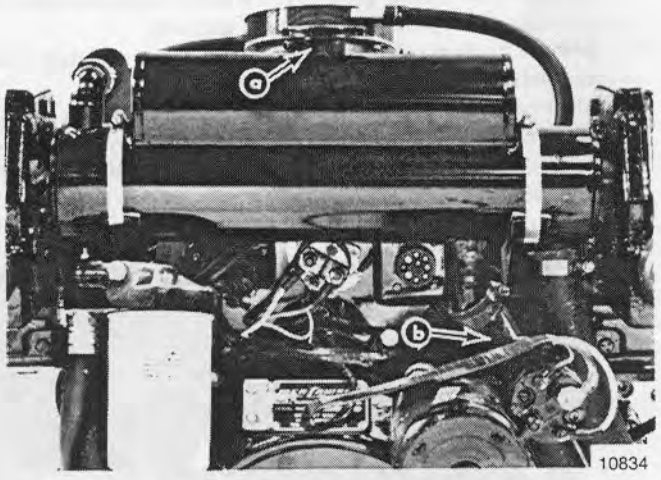
a - Petcock (1)
b - Drain Plug (1)

Figure 2. MIE 228/255 (Port)



a - Pressure Cap
b - Hose

Figure 3. MIE 228/255 (Front Mounted Tank)



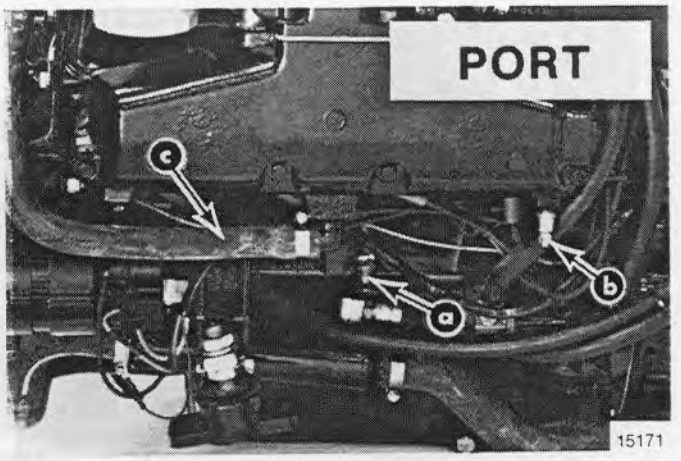
a - Pressure Cap
b - Hose

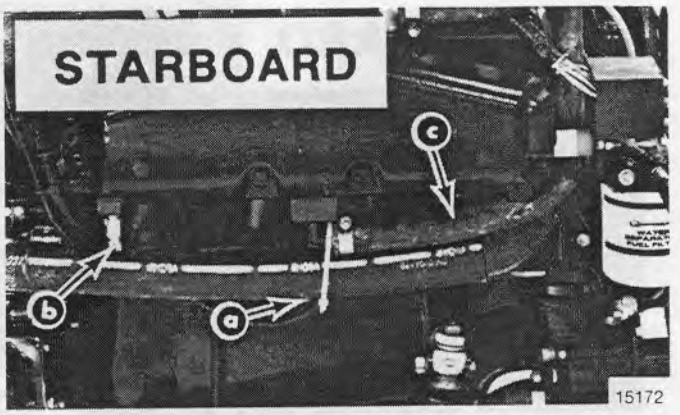
Figure 4. MIE 228/255 (Rear Mounted Tank)

MIE 230/260

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

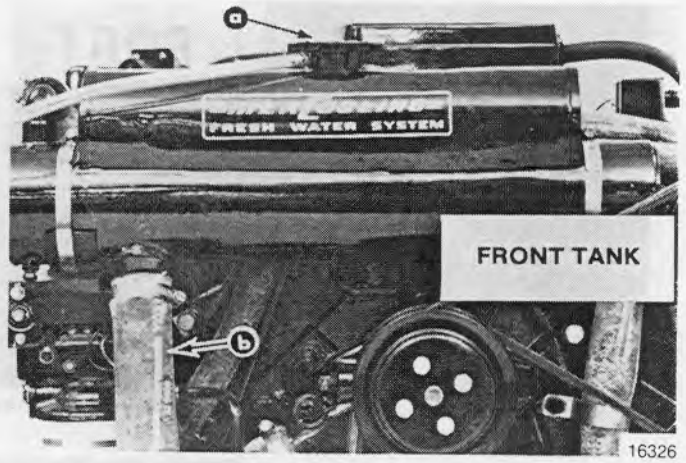
1. Engine must be level to properly drain cooling sytem.
2. Remove pressure cap from reservoir.
3. Drain coolant as shown in Figures 1 and 2.
4. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
5. Remove coolant recovery bottle from mounting bracket and pour out coolant.
6. Clean system as outlined in "Cleaning System".
7. Fill system as outlined in "Filling Closed Cooling Section".

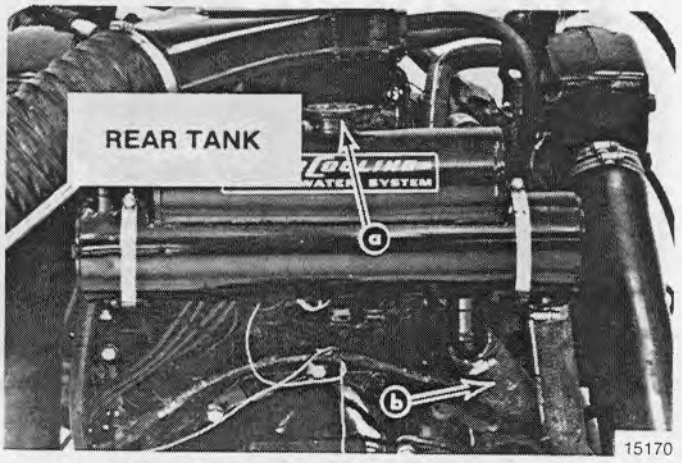




a - Remove 2 Cylinder Block Petcocks (1 Hidden)
b - Remove 2 Exhaust Manifold Petcocks
c - Remove 2 Hoses and Lower to Drain

Figure 1. MIE 230/260





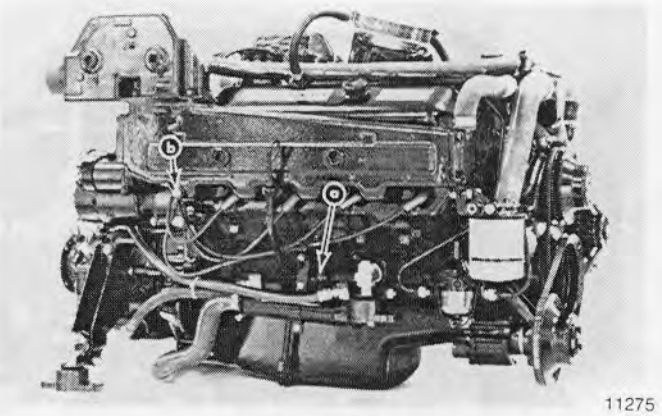
a - Remove Pressure Cap
b - Remove Hose and Lower to Drain

Figure 2. MIE 230/260

MIE 330

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

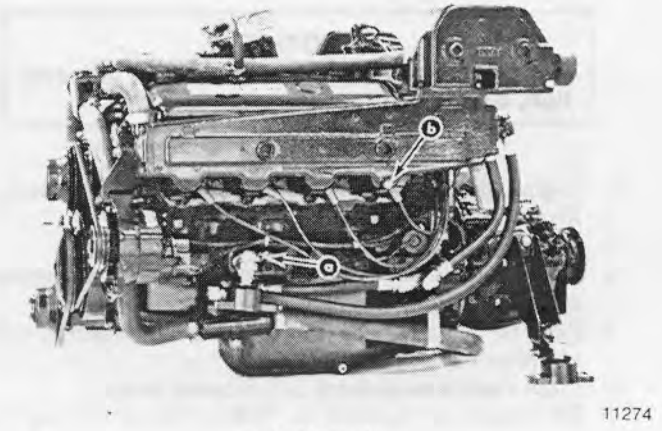
1. Engine must be level to properly drain cooling sytem.
2. Remove pressure cap from heai exchanger.
3. Remove drain plug from port and starboard exhaust manifolds and open cylinder block petcocks on each side of block. (Figures 1 and 2)
4. Disconnect heat exchanger to circulating pump hose from circulating pump and bend hose to allow coolant to drain. (Figures 3 and 4)
5. Remove coolant recovery reservoir from mounting bracket and pour out coolant.
6. After coolant had drained completley, coat threads of drain plugs with Perfect Seal and reinstall. Close cylinder block petcocks and reconnect hose to circulating pump.
7. Clean system as outlined in "Cleaning System".



a - Petcock (1)
b - Drain Plug (1)

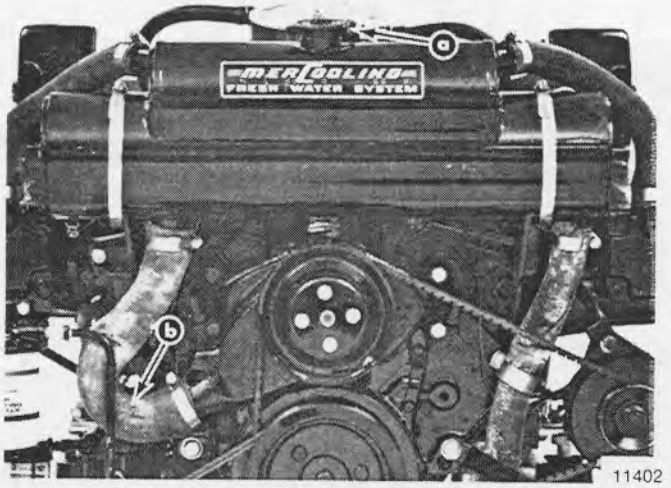
Figure 1. MIE 330 (Starboard)

8. Fill system as outlined in "Filling Closed Cooling Section".



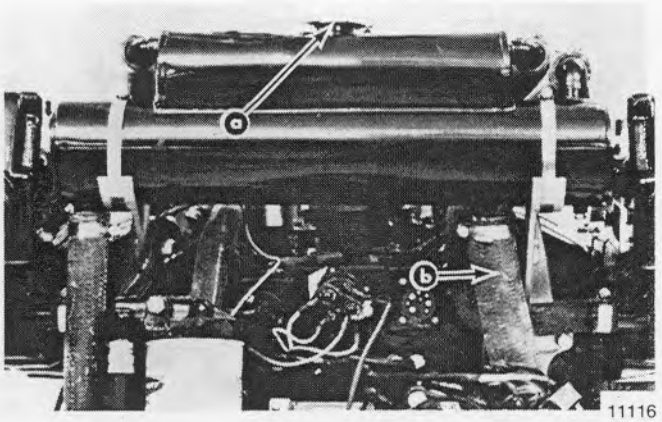
a - Petcock (1)
b - Drain Plug (1)

Figure 2. MIE 330 (Port)



a - Pressure Cap
b - Hose

Figure 3. MIE 330 (Front Mounted Tank)



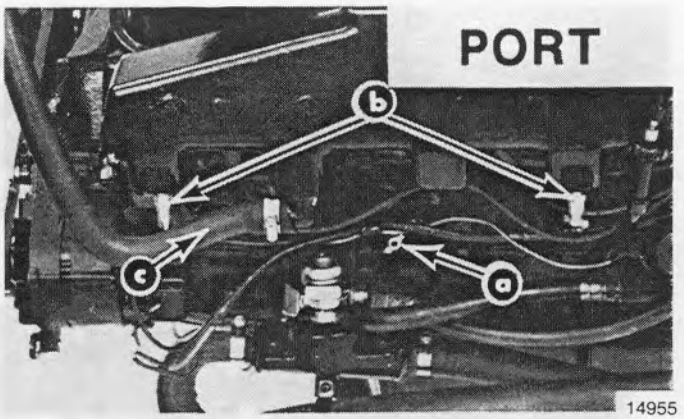
a - Pressure Cap
b - Hose - Disconnect at Circulating Pump

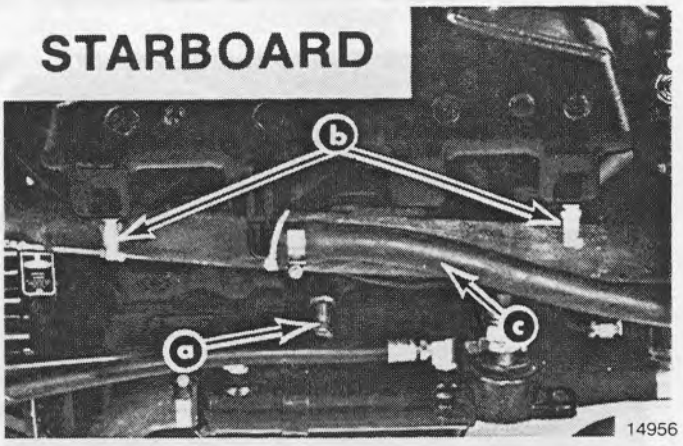
Figure 4. MIE 330 (Rear Mounted Tank)

MIE 340

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

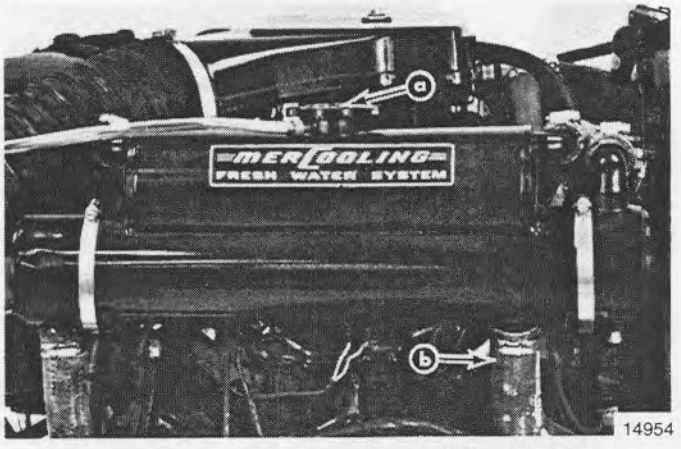
1. Engine must be level to properly drain cooling system.
2. Remove pressure cap.
3. Drain coolant as shown in Figures 1 and 2.
4. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
5. Remove coolant recovery bottle from mounting bracket and pour out coolant.
6. Clean system as outlined in "Cleaning System".
7. Fill system as outlined in "Filling Closed Cooling Section.".





a - Remove 2 Cylinder Block Petcocks
b - Remove 4 Exhaust Manifold Petcocks
c - Remove 2 Hoses and Lower to Drain

Figure 1. MIE 340



a - Remove Pressuer Cap
b - Remove Hose and Lower to Drain

Figure 2. MIE 340

CLEANING SYSTEM

CLOSED COOLING SECTION

Closed cooling section of Closed Cooling System should be cleaned at least once every 2 years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Manufacturer's instructions, which accompany particular cleaner, always should be followed.

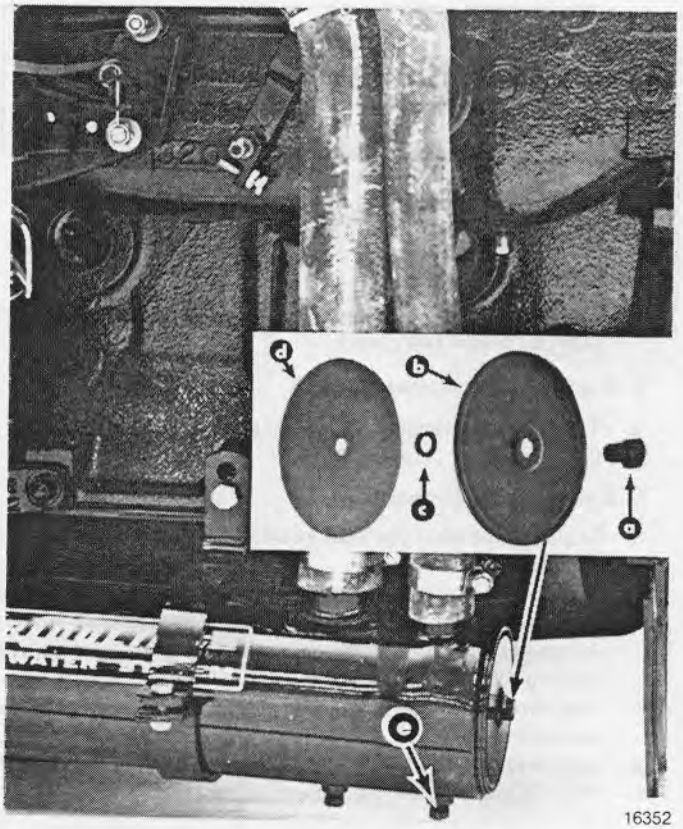
If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hookup and flushing procedure.

SEAWATER SECTION

Cooling efficiency of an engine with Closed Cooling is greatly dpendent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommeded that the seawater section of the heat exchanger be cleaned at least once every 2 years or whenever decreased cooling efficiency is suspected, as follows:

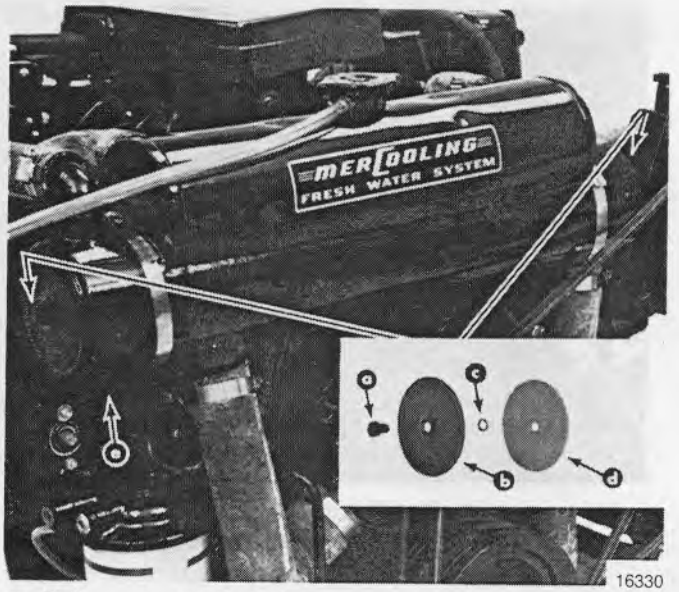
IMPORTANT: It may be necessary to remove heat exchanger on some models. If heat exchanger is removed, be sure to refill closed cooling section with coolant.

1. Remove seawater drain plug from bottom of heat exchanger and allow water to drain. After water has drained completely, coat threads of drain plug with Perfect Seal and reinstall. (Figure 1 or 2)
2. Remove bolts, which secure end plates to each end of heat exchanger, then remove end plates, seal washers and gaskets. Discard seal washers and gaskets. Clean gasket material from end plates and heat exchanger. (Figure 1 or 2)
3. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
4. Apply Perfect Seal to both sides of new end plate gaskets, then reinstall end plates, using new gaskets and seal washers. (Figure 1 or 2) (Be sure to install seal washers between end plates and gaskets.) Torque end plate bolts to specifications.
5. Start engine and inspect cooling system for leaks.



a - Bolt
b - End Cap
c - Sealing Washer
d - Gasket
e - Drain Plug

Figure 1. MCM 120/140/165



a - Bolt
b - End Cap
c - Sealing Washer
d - Gasket
e - Drain Plug (Refer to "Out-of-Season Storage" for Location on Model Being Worked On)

Figure 2. Typical V-8 Engine

FILLING CLOSED COOLING SECTION

NOTICE
See "Specifications" for appoximate closed cooling system capacity and coolant recommedation.

1. Fill closed cooling section with coolant as follows:

MCM 120/140/165

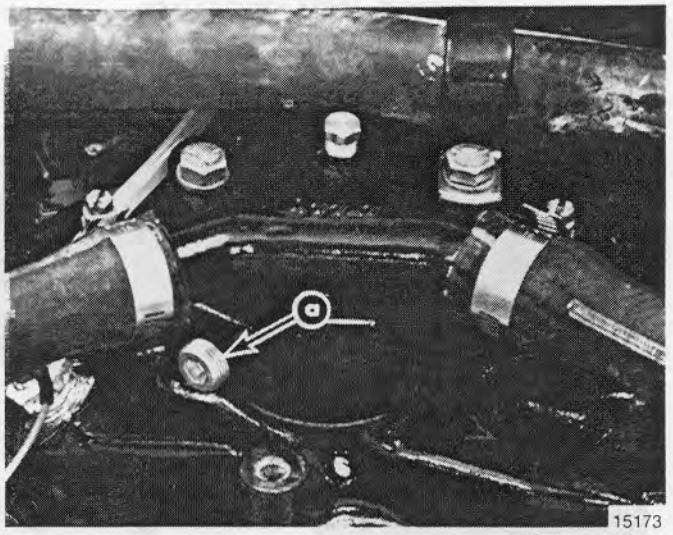
a. Thru reservior filler neck until coolant solution is 1" (25mm) below filler neck.

V-8 with Front Mounted Tank

a. Thru heat exchanger filler neck until coolant solution is 1" (25mm) below filler neck.

V-8 with Rear Mounted Tank

a. Remove pipe plug (or heat switch) from thermostat housing. (Figure 1)
b. Fill Closed Cooling section with coolant solution thru heat exchanger filler neck until coolant appears at hole in thermostat housing from which pipe plug (or heat switch) was removed.
c. Coat threads of pipe plug (or heat switch) with Perfect Seal and reinstall.
d. Continue filling Closed Cooling section until coolant level is 1" (25mm) below filler neck.



a - Pipe Plug (or Heat Switch)

Figure 1. V-8 Thermostat Housing

⚠CAUTION

- **DO NOT operate engine without water flowing thru seawater pickup pumps, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.**
- **Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the posibility of air being trapped in the closed cooling section which can cause engine to overheat.**
- **Models with belt drive seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.**

2. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to heat exchanger, as required, to maintain coolant level 1" below filler neck.
3. After engine has reached normal operating temperature (themostat is fully open), and coolant level remains constant, fill heat exchanger to bottom of filler neck.
4. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
5. Install pressure cap on heat exchanger.
6. Remove cap from coolant recovery reservoir and fill to "Full" mark wiht coolant solution. Reinstall cap.
7. With engine still running, check hose connections, fittings and gaskets for leaks. Repeat step 4.

IMPORTANT: Engine overheating is often due to air being trapped in fresh water section. Purge air by running engine at 2000 RPM for 10 minutes.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap ¼-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

8. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
9. Maintain coolant level in coolant recovery reservoir between "Add" and "Full" marks with engine at normal operating temperature.

OUT-OF-SEASON STORAGE

CLOSED COOLING SECTION

Closed cooling section of Closed Cooling System should be kept filled year around with recommeded coolant solution. DO NOT drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol anti-freeze and water solution, mixed to manufacturer's recommeded proportion, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

SEAWATER SECTION DRAINING PRECAUTIONS

⚠CAUTION

If the possibility of freezing exists, seawater section MUST BE drained to prevent freeze damage to cooling system and engine. Seawater section also should be drained if boat is to be stored for an extended period of time, to prevent corrosion damage.

⚠CAUTION

If boat is in the water, water inlet valve (if so equipped) MUST be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose MUST BE left disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve MUST BE opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes.

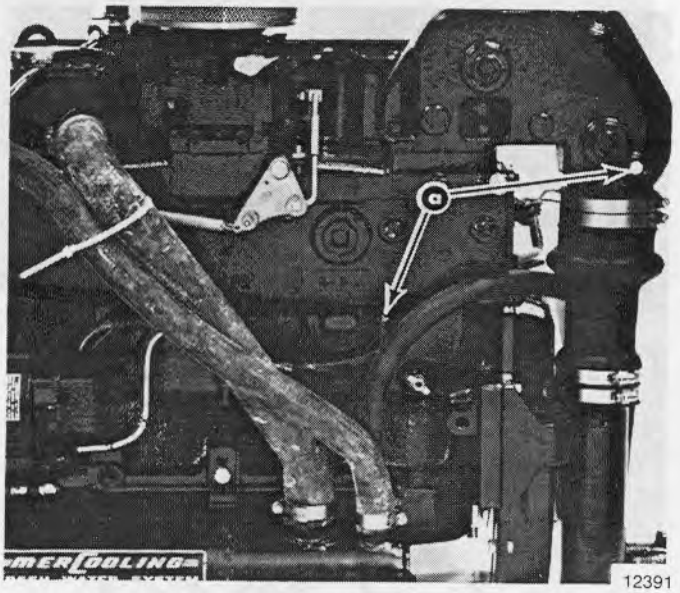
IMPORTANT: To prevent threads in elbows from rusting out during storage, reinstall plugs using Perfect Seal on threads. NEVER leave drain plugs out during storage.

NOTE: If possible, place a container under drains to prevent water from draining into boat.

MCM 120/140/165

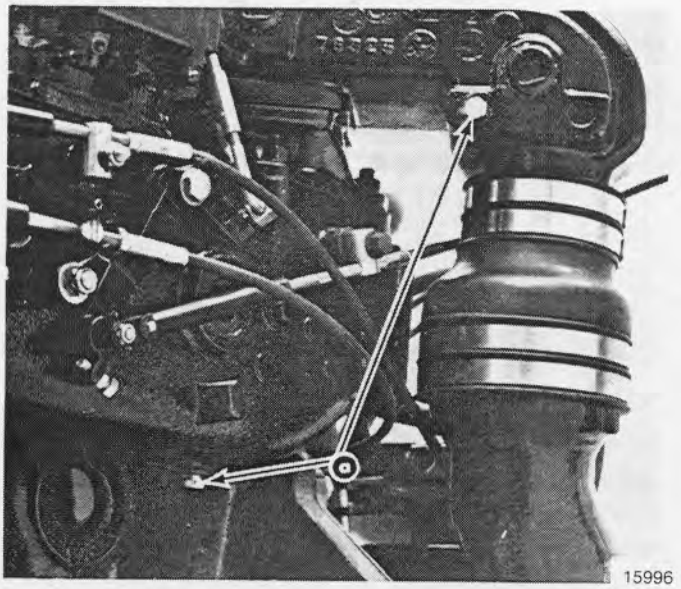
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown in Figures 1, 2, 3, 4 and 5.



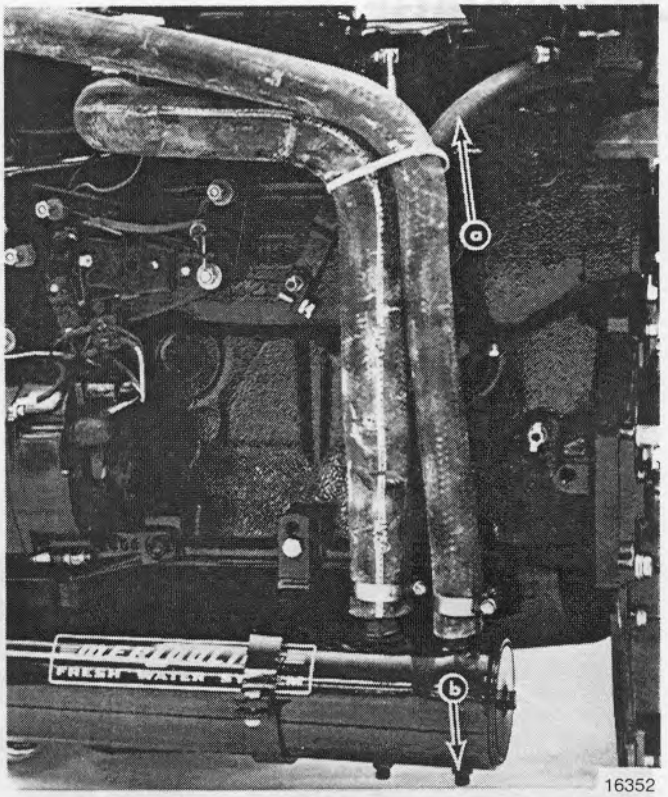
a - Remove Drain Plugs (2) (MCM 120 has a Self-Draining Elbow)

Figure 1. MCM 120/140/165



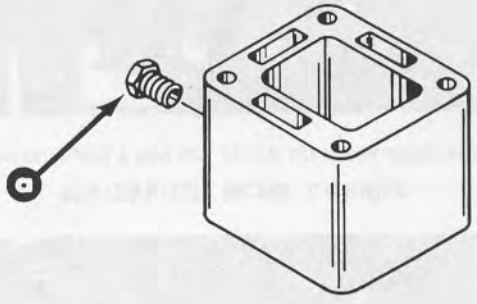
a - Remove Drain Plugs (2)

Figure 2. MCM 120R/140R



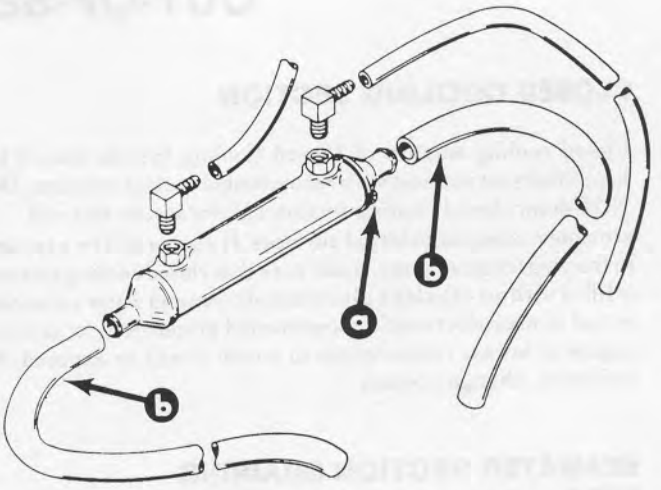
a - Disconnect Seawater Inlet Hose and Lower to Drain
b - Remove Drain Plug (1)

Figure 3. MCM 120/140/165



a - Remove Drain Plug

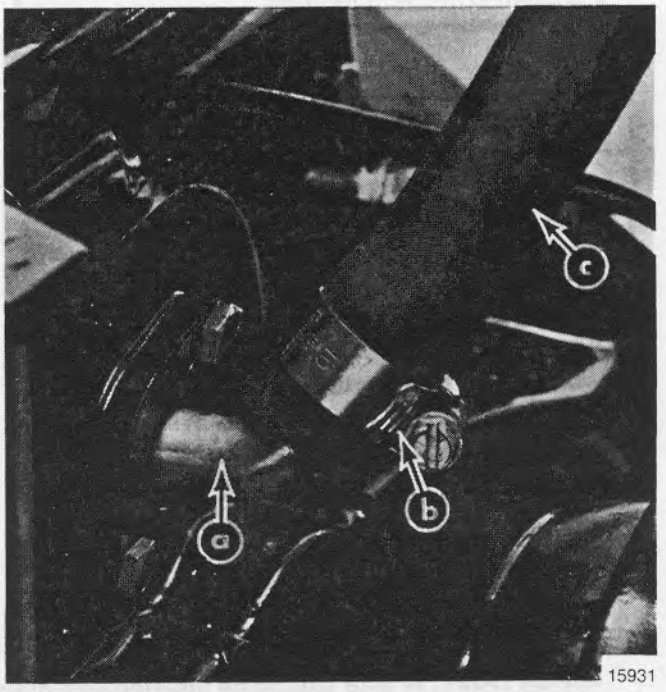
Figure 4. 3" or 6" Risers (If Equipped)



a - Remove Drain Plug
b - Cooler without Drain Plug - Remove Hoses, Lower to Drain

Figure 5. Power Steering Fluid Cooler (If Equipped)

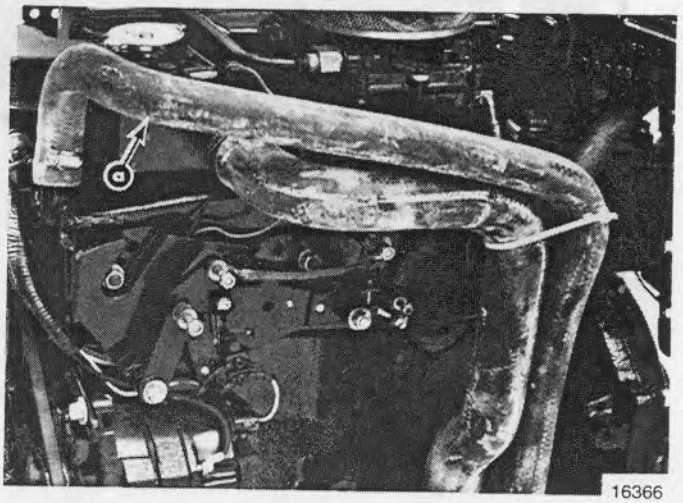
3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hose and tighten clamp securely.
4. **MCM 120R/140R Driveshaft Extension Models:** Disconnect water inlet hose from gimbal housing and lower to drain hose. (Figure 6)



a - Water Tube
b - Hose Clamp (Retighten Securely)
c - Remove Hose, Lower to Drain

Figure 6. Driveshaft Extension Models

5. For additional assurance against freezing and rust, fill the exhaust manifold and heat exchanger with a solution of permanent anti-freeze and water (mixed to proportions recommeded by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill manifold and exchanger refer to Figure 7.



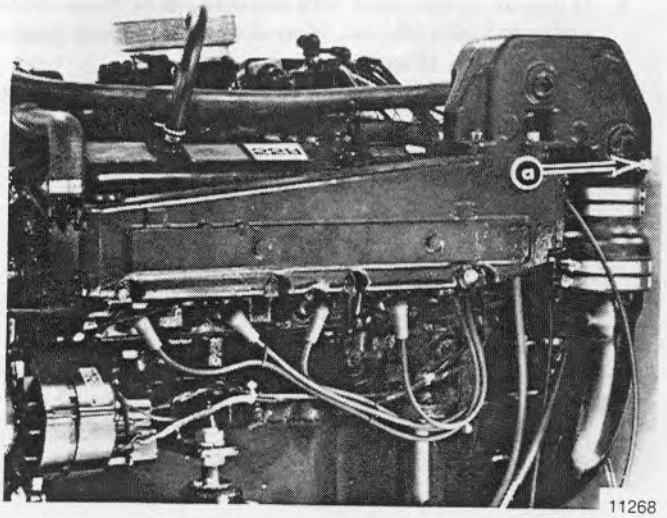
a - Remove Hose From Manifold End Cap. Pour Coolant into Manifold, Then into Hose until Heat Exchanger is Full. Reconnect Hose. Tighten Clamp Securely

Figure 7. Filling with Coolant

MCM 898/228/260

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

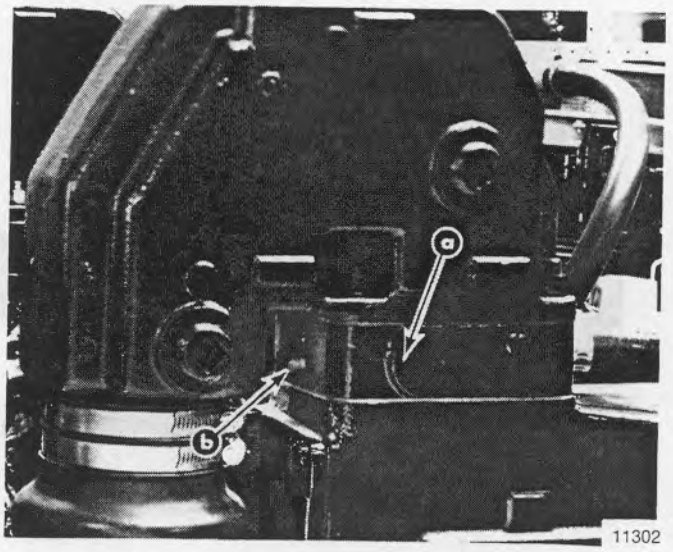
1. Engine must be level to properly drain cooling system.
2. Remove drain plugs from port and starboard exhaust elbows. (Figure 1)
3. Remove drain plug from aft end of each water distribution block. (Figure 2)



a - Remove Drain Plugs, 1 Each Elbow

Figure 1. MCM 898/228/260

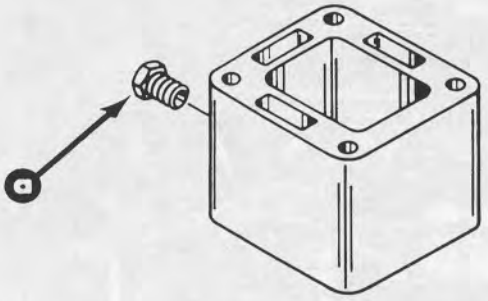
1. Engine must be level to properly drain cooling system.



a - Water Distribution Block
b - Remove Drain Plugs

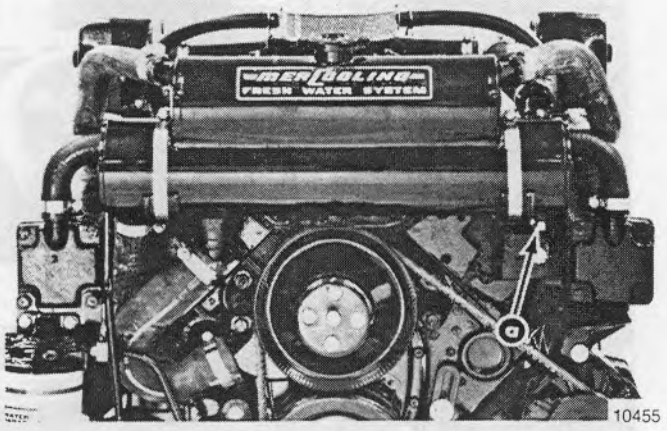
Figure 2. MCM 898/228/260

4. If engine is equipped with exhaust elbow risers (located under exhaust elbows), remove drain plug from front end of each riser. (Figure 3)
5. Remove drain plug from bottom of heat exchanger. (Figure 4)



a - Remove Drain Plug

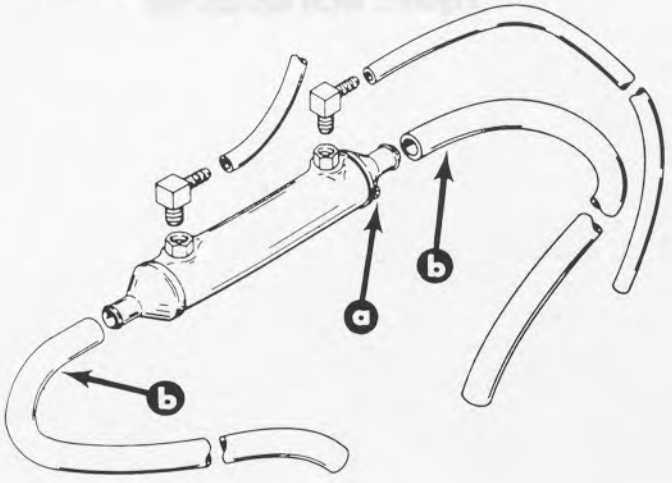
Figure 3. 3" or 6" Risers (If Equipped)



a - Remove Drain Plug

Figure 4. MCM 898/228/260

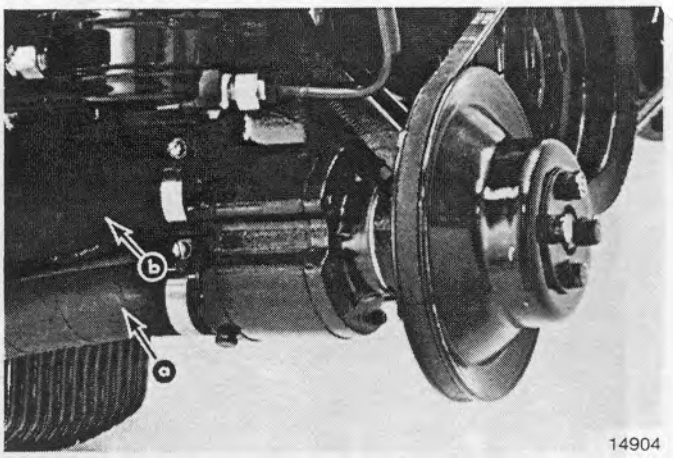
6. **Power Steering Models:** Drain fluid cooler as shown in Figure 5.



a - Remove Drain Plug
b - Cooler without Drain Plug - Remove Hoses, Lower to Drain

Figure 5. Power Steering Fluid Cooler

7. Disconnect inlet and outlet hoses from aft end of seawater pickup pump. (Figure 6) Take note of each hose connection location, as hoses MUST BE reconnected the same way.



a - Remove Inlet Hose
b - Remove Outlet Hose

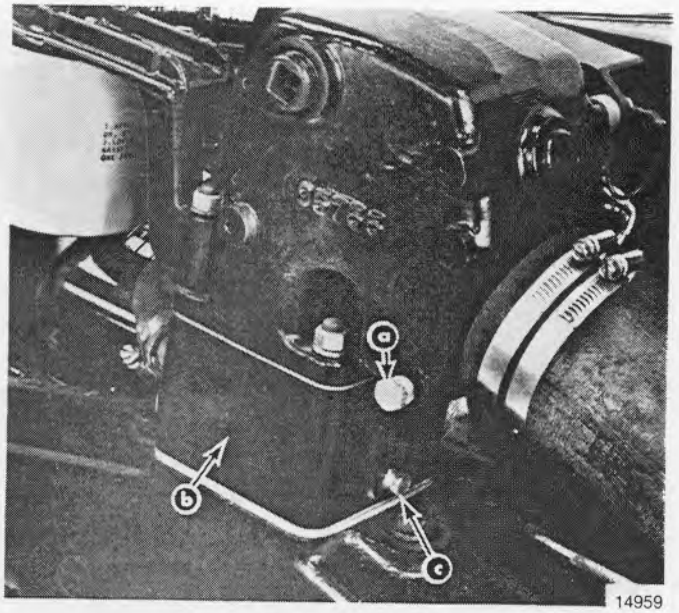
Figure 6. MCM 898/228/260

8. After seawater section has drained completely, coat threads of drain plugs with Perfect Seal and reinstall.
9. Reconnect seawater pickup pump hoses and tighen clamps securely.

MCM 898R/228R/260R

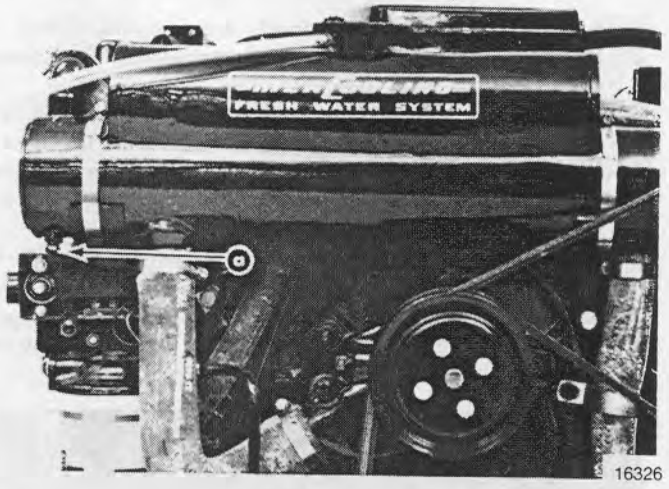
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Drain system as shown. Figures 1, 2, 3, and 4. Engine must be level to properly drain cooling system.
2. Crank engine over slightly, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT allow engine to start.
3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hoses. Be sure to tighten hose clamps and drain plugs securely.



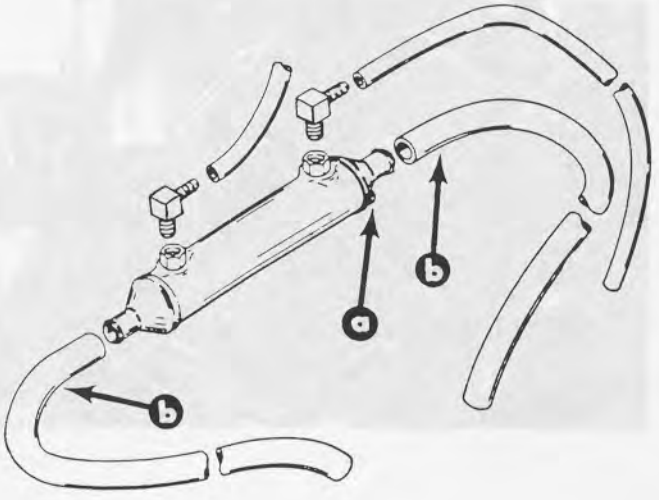
a - Remove Drain Plug - 1 Each Elbow
b - 3" or 6" Riser (If Equipped)
c - Remove Drain Plug, 1 Each Riser

Figure 1. MCM 898R/228R/260R



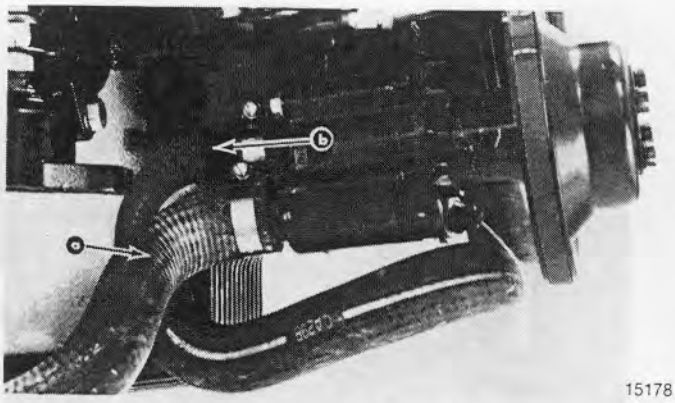
a - Remove Drain Plug

Figure 2. MCM 898R/288R/260R



a - Remove Drain Plug
b - Cooler without Drain Plug - Remove Hoses, Lower to Drain

Figure 3. Power Steering Fluid Cooler



a - Remove Inlet Hose, Lower to Drain
b - Remove Outlet Hose, Lower to Drain

Figure 4. MCM 898R/228R/260R

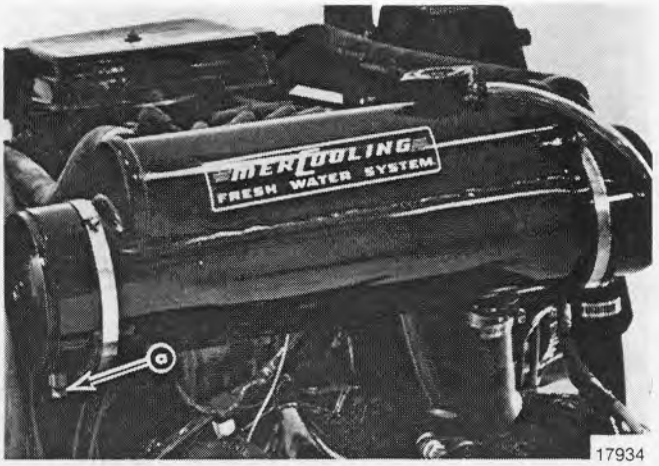
MCM 330 (B-W)

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Drain system as shown. Figures 1, 2, 3, and 4. Engine must be level to properly drain cooling system.
2. Crank engine over slightly, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT allow engine to start.
3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hoses. Be sure to tighten hose clamps and drain plugs securely.

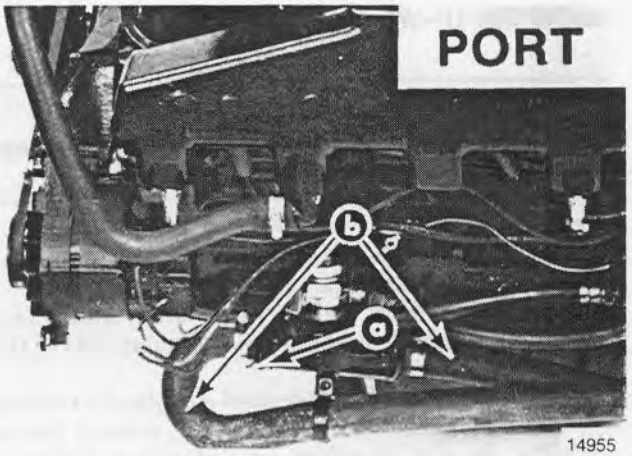
a - Remove Drain Plug, 1 Each Elbow
b - 3" or 6" Riser (If Equipped)
c - Remove Drain Plug, 1 Each Riser

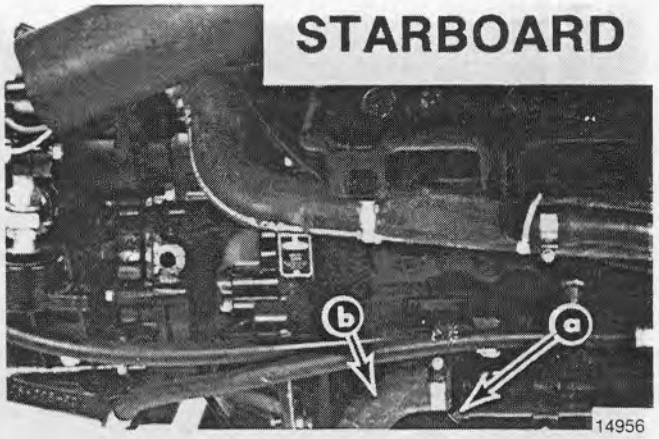
Figure 1. MCM 330 (B-W)



a - Remove Drain Plug

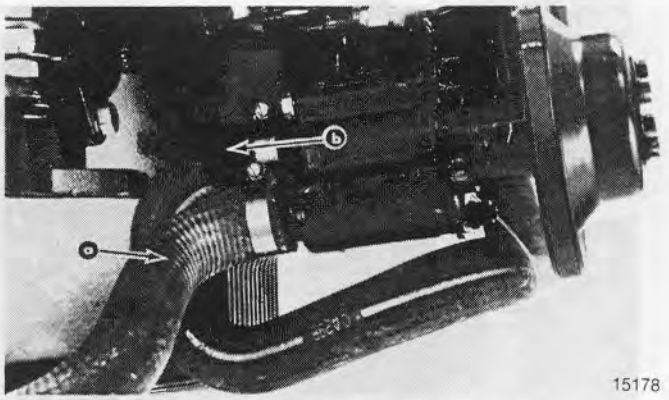
Figure 2. MCM 330 (B-W)





a - Remove Drain Plugs (2)
b - Remove Hoses, Lower to Drain

Figure 3. MCM 330 (B-W) Coolers



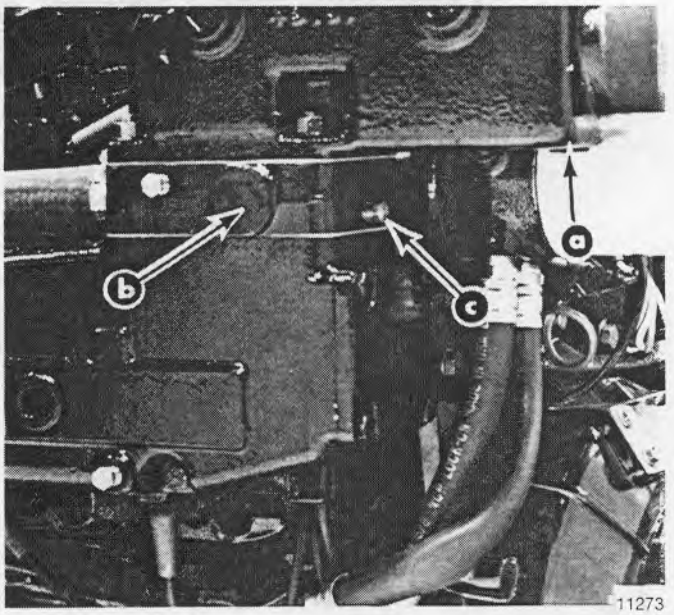
a - Remove Inlet Hose, Lower to Drain
b - Remove Outlet Hose, Lower to Drain

Figure 4. MCM 330 (B-W)

MIE 228/255

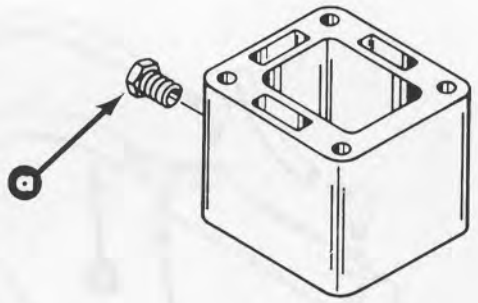
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level to properly drain cooling system.
2. Remove drain plug from port and starboard exhaust elbow. (Figure 1)
3. On engines with 2 passage water distribution blocks, remove drain plug from aft end of each block. (Figure 1)
4. If engine is equipped with exhaust elbow risers (located under exhaust elbow), (Figure 2) remove drain plug from end of each riser.
5. Remove drain plug from bottom of heat exchanger. (Figure 3 or 4) On engines with rear mounted heat exchanger, also disconnect transmission fluid cooler to heat exchanger hose from heat exchanger and lower to allow water to drain. (Figure 4)



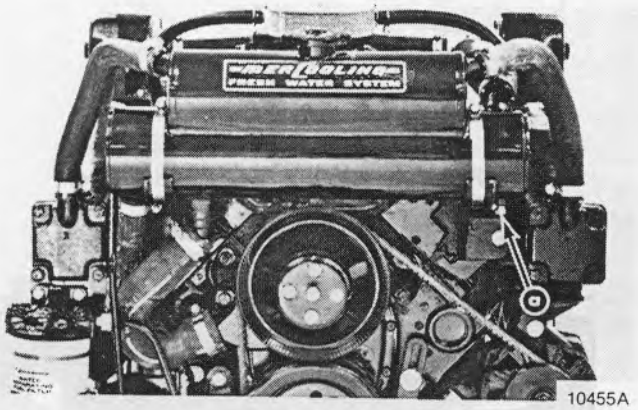
a - Remove Drain Plug (Hidden), 1 Each Elbow
b - Water Distribution Block (If Equipped)
c - Remove Drain Plug, 1 Each Block

Figure 1. MIE 228/255



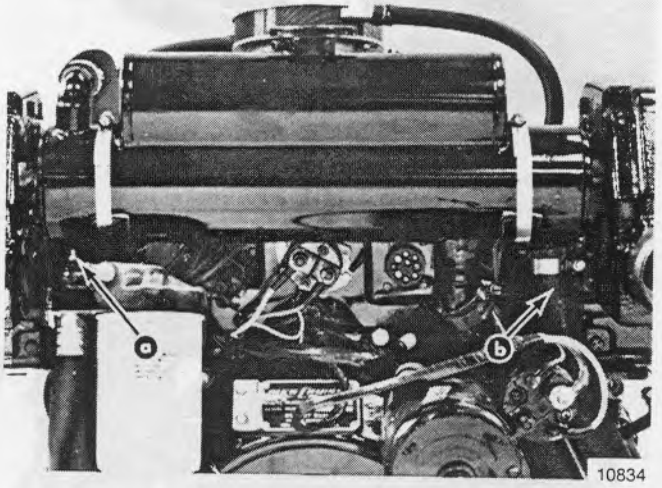
a - Remove Drain Plug, 1 Each Riser

Figure 2. 3″ or 6″ Risers (If Equipped)



a - Drain Plug (1)

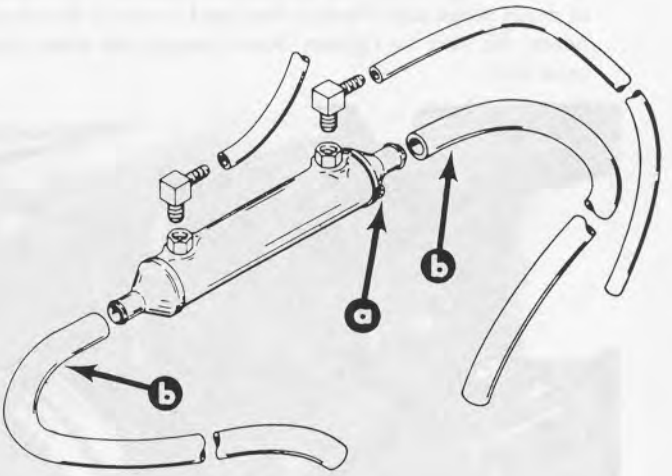
Figure 3. MIE 228/255 (Front Mounted Tank)



a - Drain Plug (1)
b - Hose

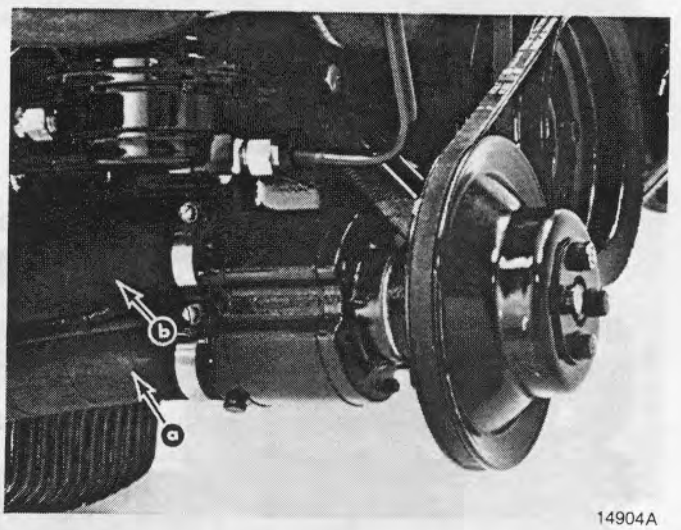
Figure 4. MIE 228/255 (Rear Mounted Tank)

6. Remove drain plug from bottom aft end of transmission fluid cooler. (Figure 5)
7. Disconnect inlet and outlet hoses from aft end of seawater pickup pump. (Figure 6) Take note of each hose connection location, as hoses MUST BE reconnected the same way later.
8. Crank engine over slightly with starter motor to purge any water remaining in seawater pickup pump. DO NOT allow engine to start.
9. After seawater section has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect all hoses and tighten clamps securely.



a - Drain Plug - Remove
b - Cooler without Drain Plug - Remove Hoses

Figure 5. Fluid Cooler

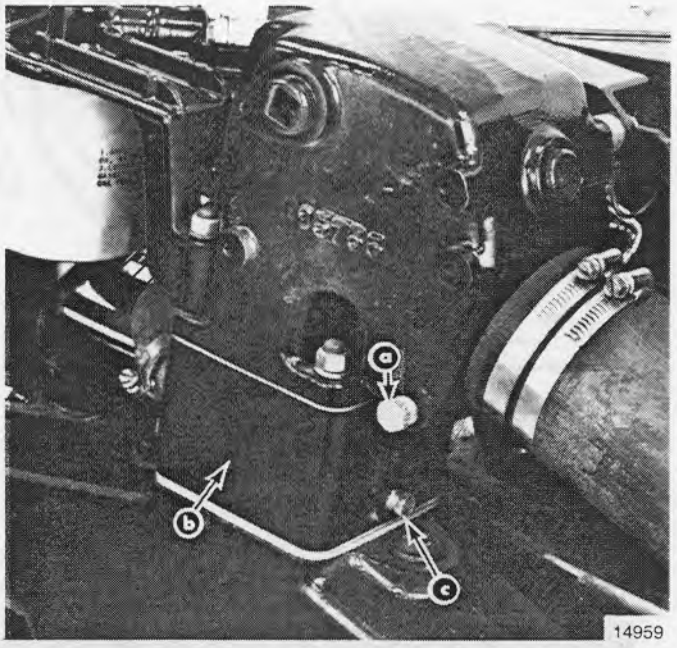


a - Inlet Hose
b - Outlet Hose

Figure 6. MIE 228/255

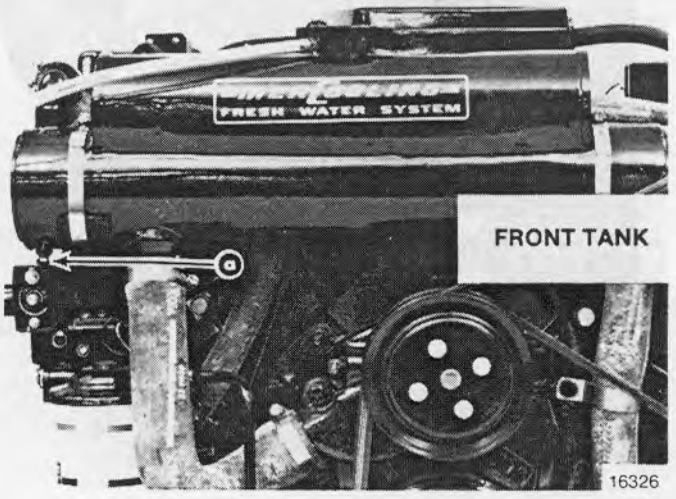
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

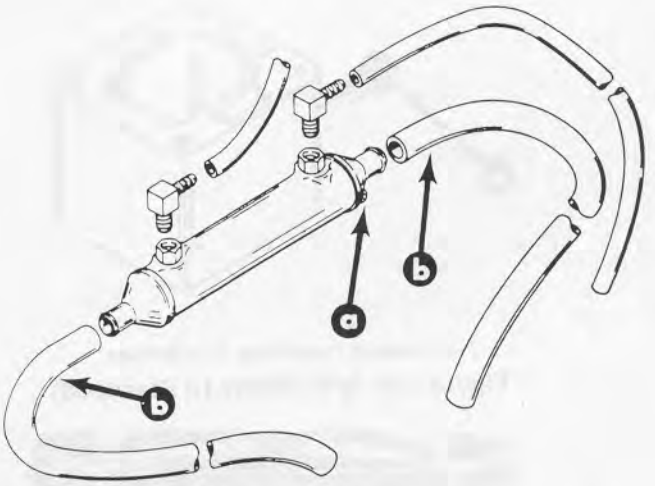
1. Drain system as shown. Figures 1, 2, 3 and 4. Engine must be level to properly drain cooling system.
2. Crank engine over slightly, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT allow engine to start.
3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hoses. Be sure to tighten hose clamps and drain plugs securely.



a - Remove Drain Plug, 1 Each Elbow
b - 3" or 6" Riser (If Equipped)
c - Remove Drain Plug, 1 Each Riser

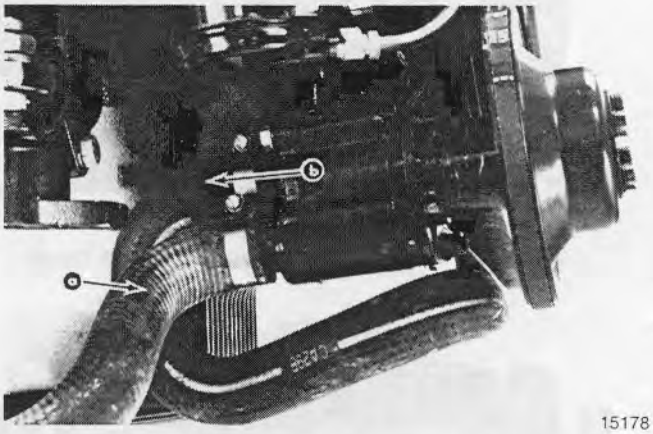
Figure 1. MIE 230/260





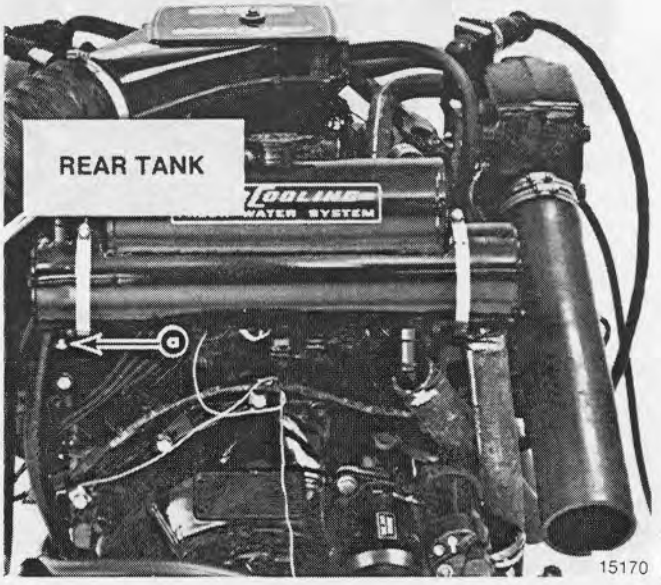
a - Remove Drain Plug
b - Remove Hoses and Lower to Drain

Figure 3. MIE 230/260 Fluid Cooler



a - Remove Inlet Hose, Lower to Drain
b - Remove Outlet Hose, Lower to Drain

Figure 4. MIE 230/260



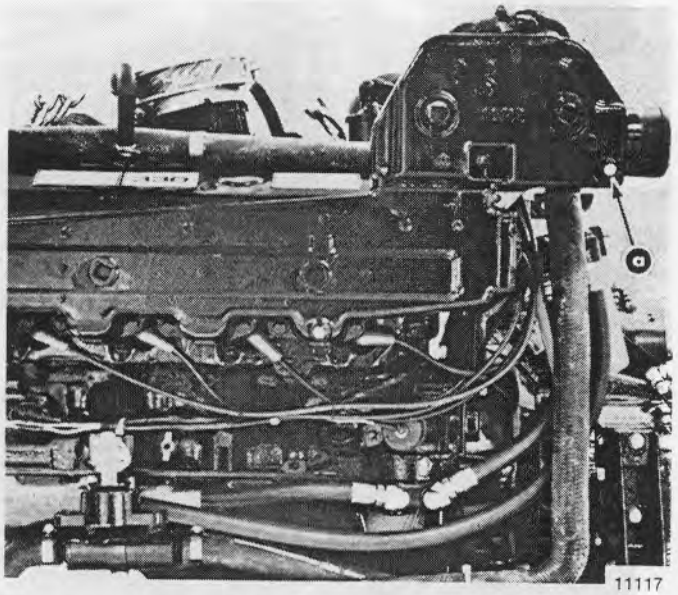
a - Remove Drain Plug (1)

Figure 2. MIE 230/260

NOTICE

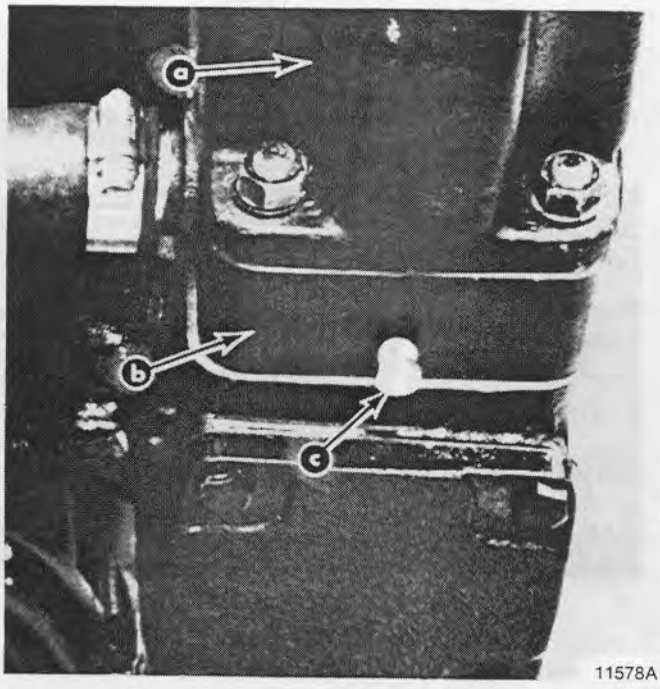
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level to properly drain cooling system.
2. Remove drain plug from port and starboard exhaust elbow. (Figure 1)
3. On engines with 2 passage water distribution blocks, remove drain plug from aft end of each distribtuion block. (Figure 2)
4. If engine is equipped with exhaust elbow risers (located under exhaust elbows), (Figure 3), remove drain plug from end of each riser.



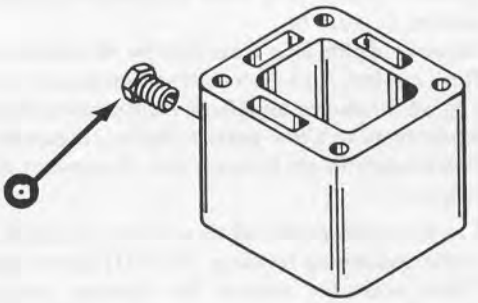
a - Drain Plug, 1 Each Elbow

Figure 1. MIE 330



a - Exhaust Elbow
b - Water Distribution Block
c - Remove Drain Plug, 1 Each Block

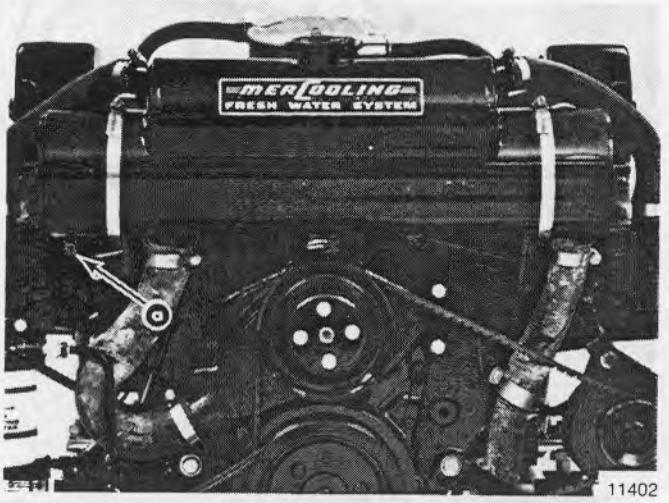
Figure 2. MIE 330 (Some Models)



a - Remove Drain Plug, 1 Each Riser

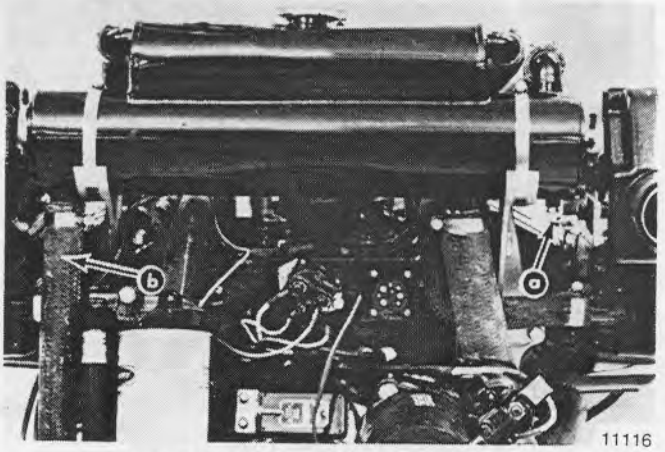
Figure 3. 3" or 6" Riser (If Equipped)

5. Remove drain plug from bottom of heat exchanger. (Figure 4 or 5). On engines with rear-mounted Closed Cooling System, also disconnect engine oil cooler to heat exchanger hose from heat exchanger and lower to allow water to drain. (Figure 5)



a - Drain Plug

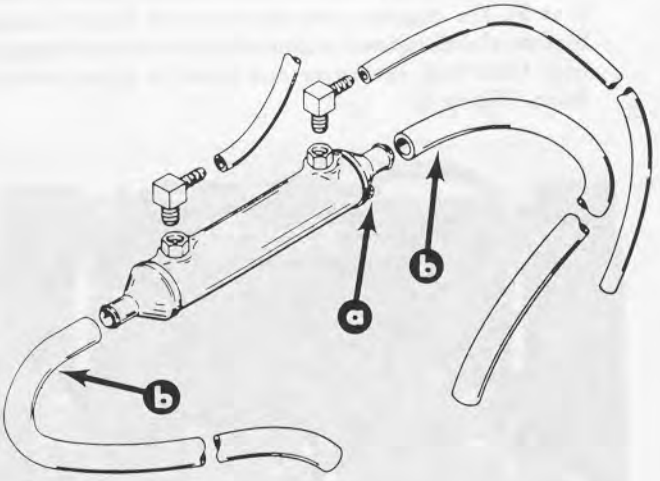
Figure 4. MIE 330 (Front Mounted Tank)



a - Drain Plug b - Hose, Lower to Drain

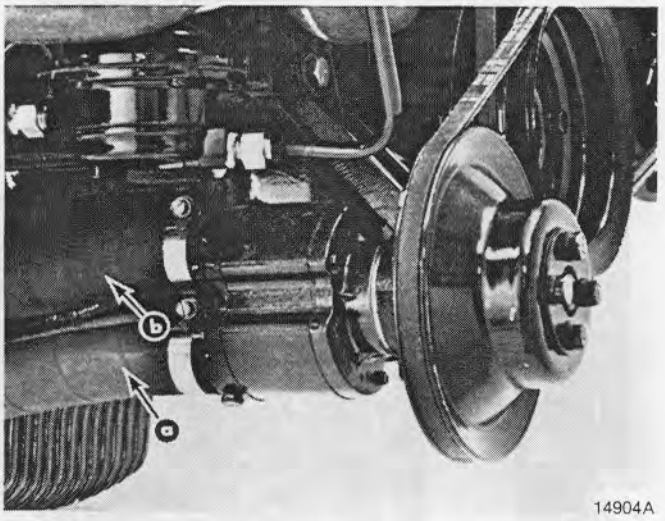
Figure 5. MIE 330 (Rear Mounted Tank)

6. Remove drain plug from bottom-aft end of engine oil cooler. (Figure 6)
7. Remove drain plug from bottom-aft end of transmission fluid cooler. Also disconnect transmission fluid cooler to engine oil cooler hose from transmission fluid cooler and lower hose to allow water to drain. (Figure 6)
8. Disconnect hoses from aft end of seawater pickup pump. (Figure 7)
9. Crank engine over slightly with starter motor to drain any water remaining in pump. DO NOT allow engine to start.
10. After seawater section has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect all hoses and tighten clamps securely.



a - Remove Drain Plug
b - Hoses - Remove and Lower to Drain

Figure 6. MIE 330 Fluid and Oil Coolers

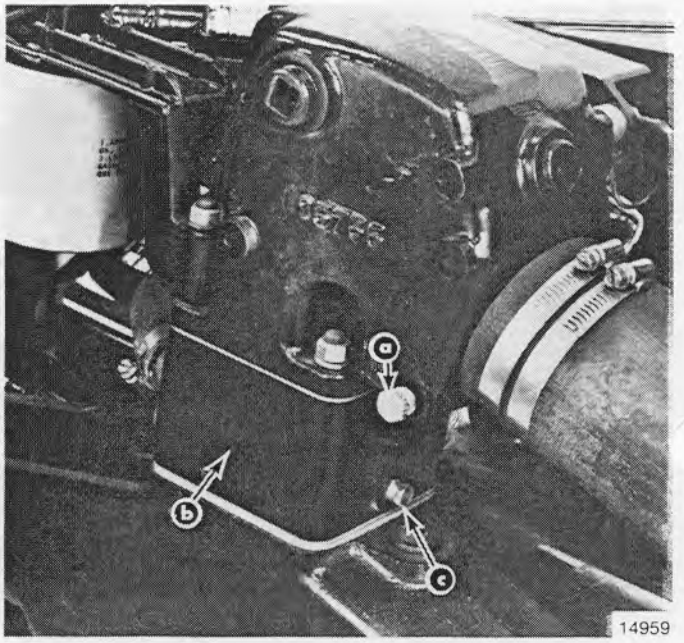


a - Remove Inlet Hose, Lower to Drain
b - Remove Outlet Hose, Lower to Drain

Figure 7. MIE 330

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Drain system as shown. Figures 1, 2, 3 and 4. Engine must be level to properly drain cooling system.
2. Crank engine over slightly, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT allow engine to start.
3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hoses. Be sure to tighten hose clamps and drain plugs securely.

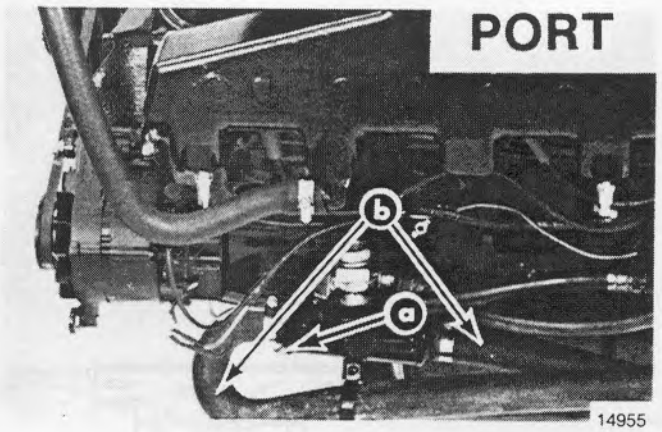


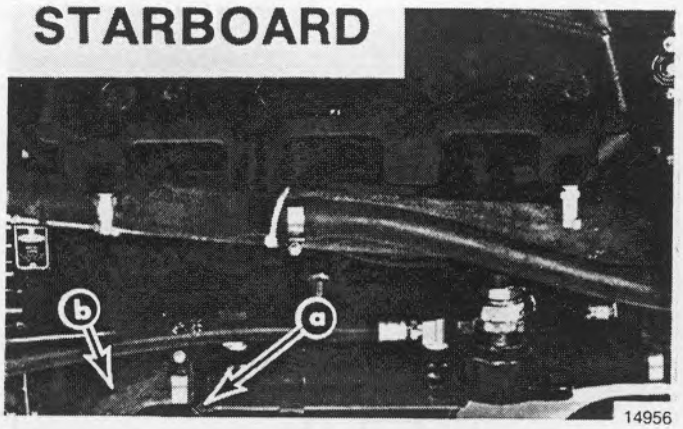
a - Remove Drain Plug, 1 Each Elbow
b - 3" or 6" Riser (If Equipped)
c - Remove Drain Plug, 1 Each Riser

Figure 1. MIE 340

a - Remove Drain Plug

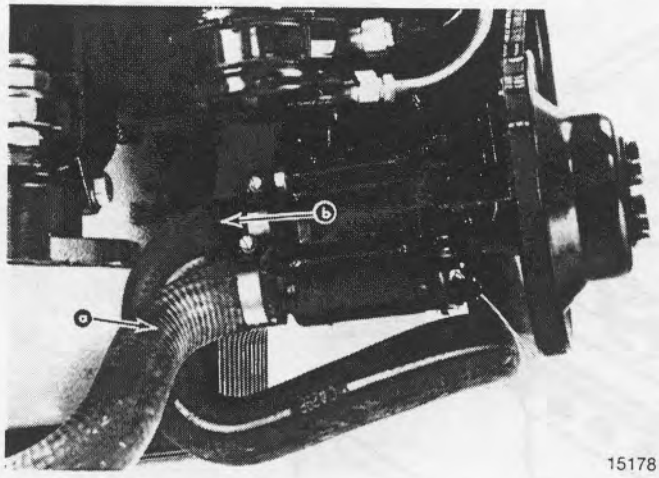
Figure 2. MIE 340





a - Remove Drain Plugs (2)
b - Remove Hose, Lower to Drain

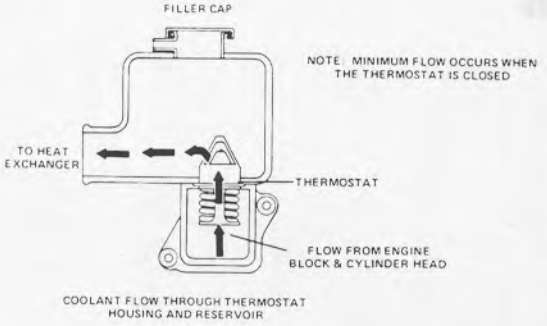
Figure 3. MIE 340 Coolers



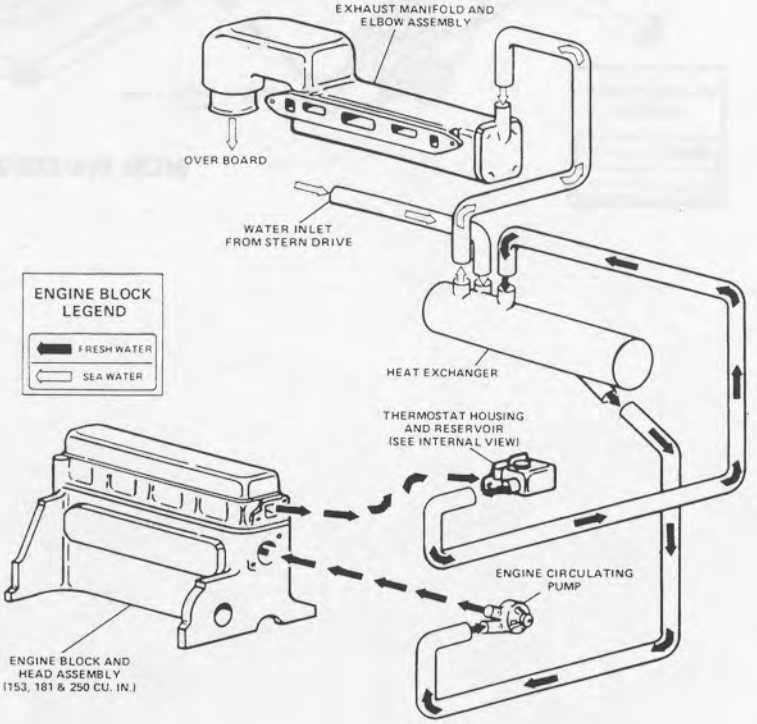
a - Remove Inlet Hose, Lower to Drain
b - Remove Outlet Hose, Lower to Drain

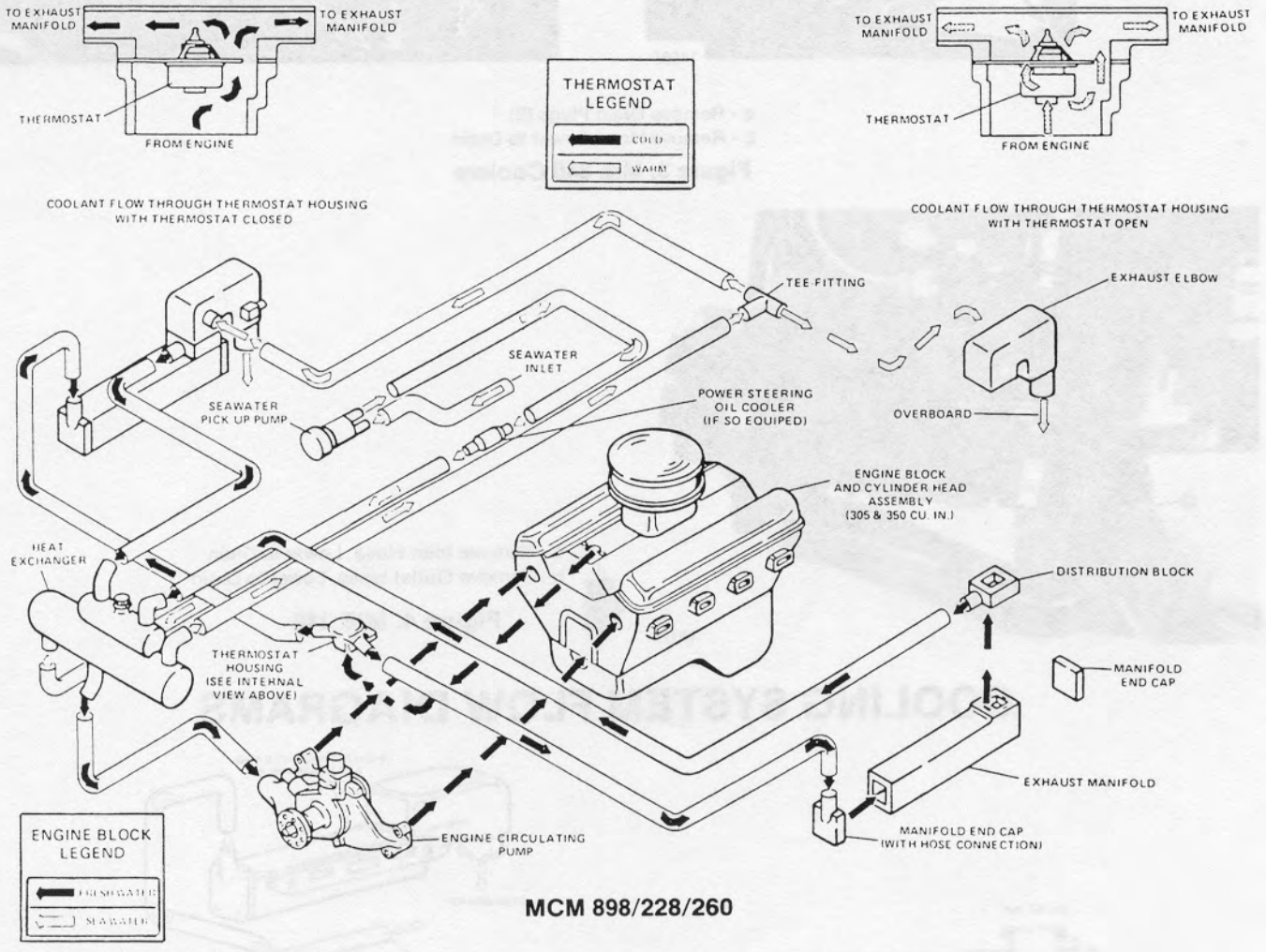
Figure 4. MIE 340

COOLING SYSTEM FLOW DIAGRAMS

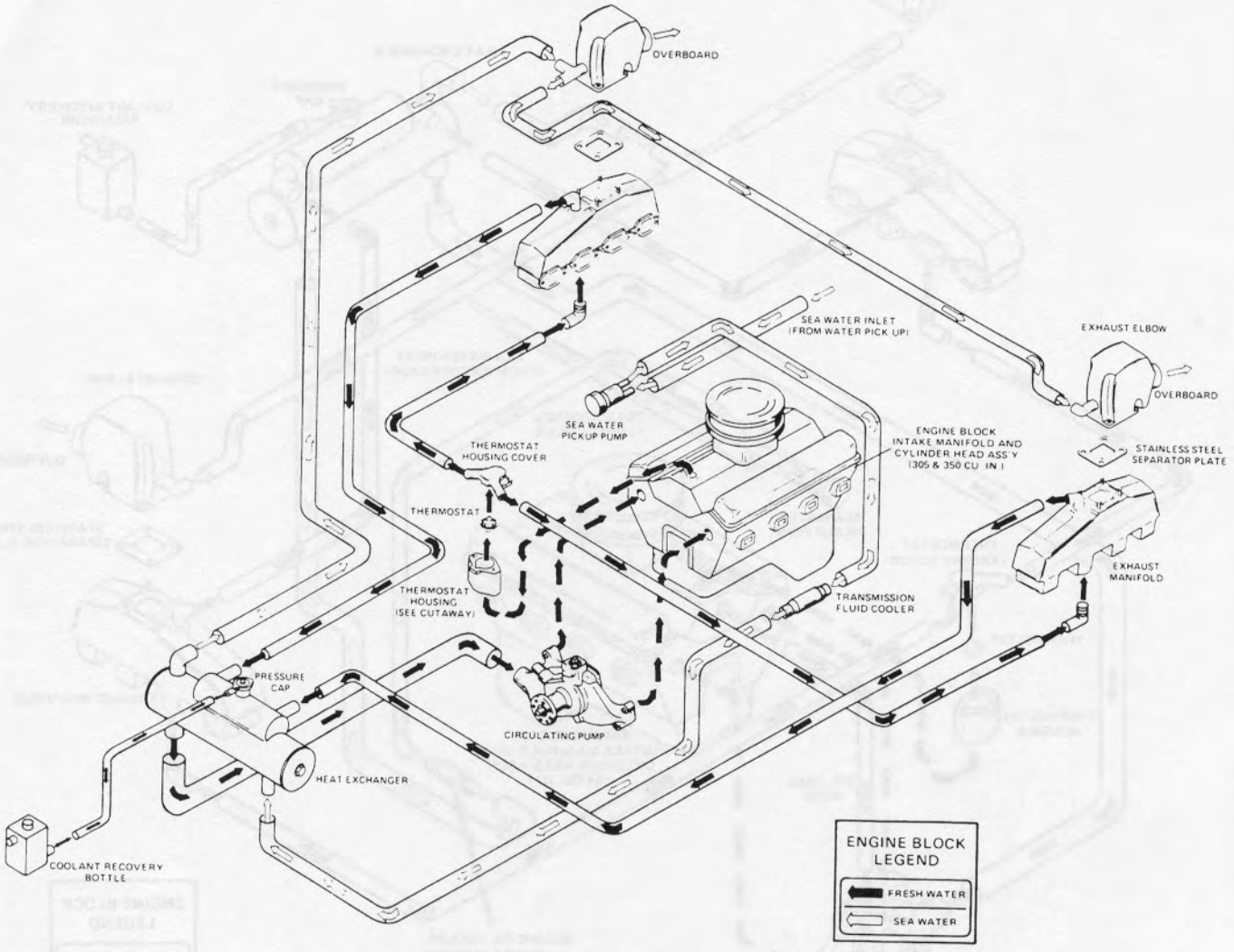


MCM 120/140/165

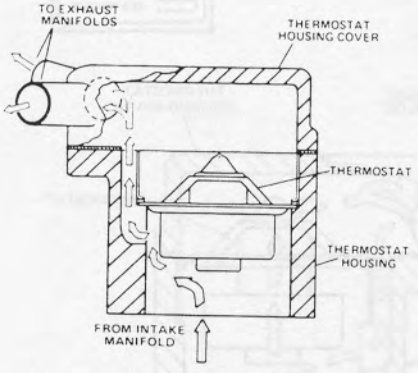




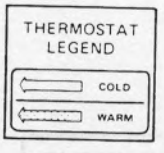
MCM 898/228/260

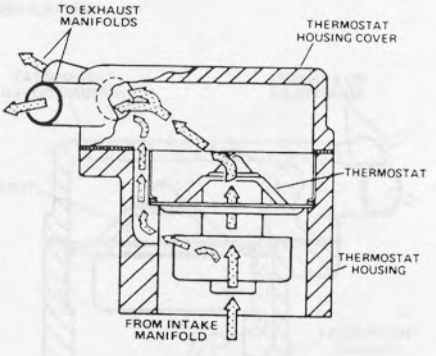


243-H



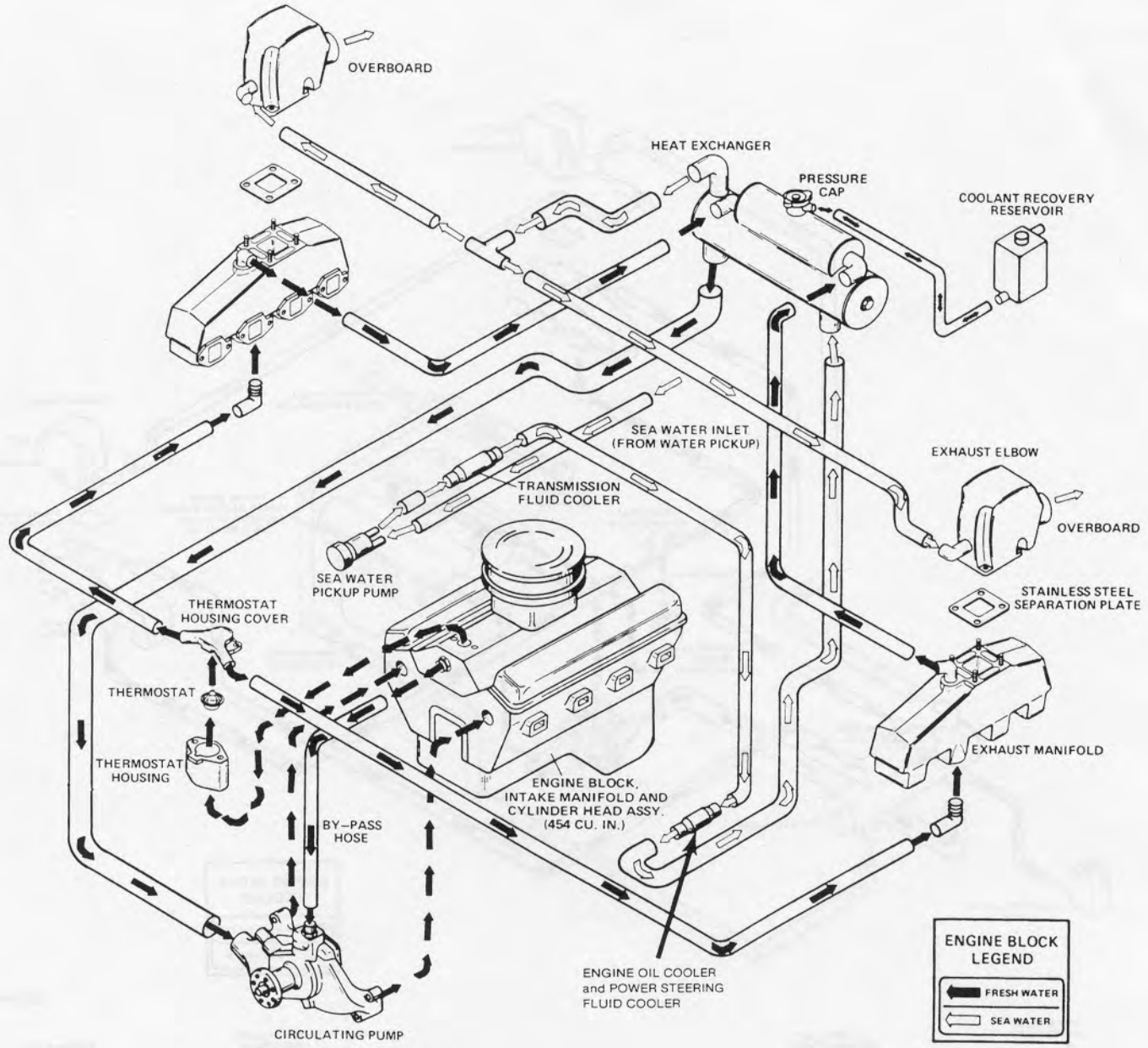
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)

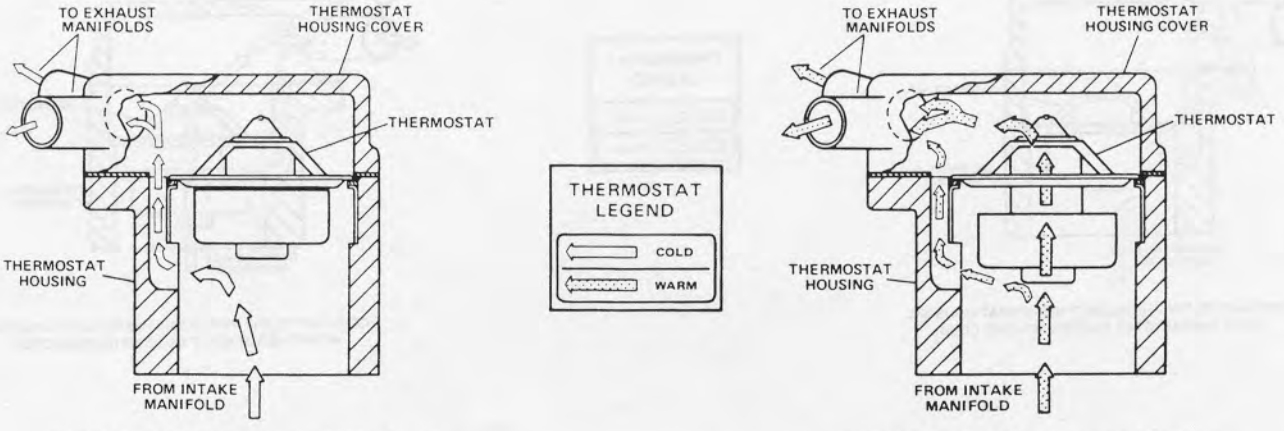




COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)

MCM 898R/228R/260R



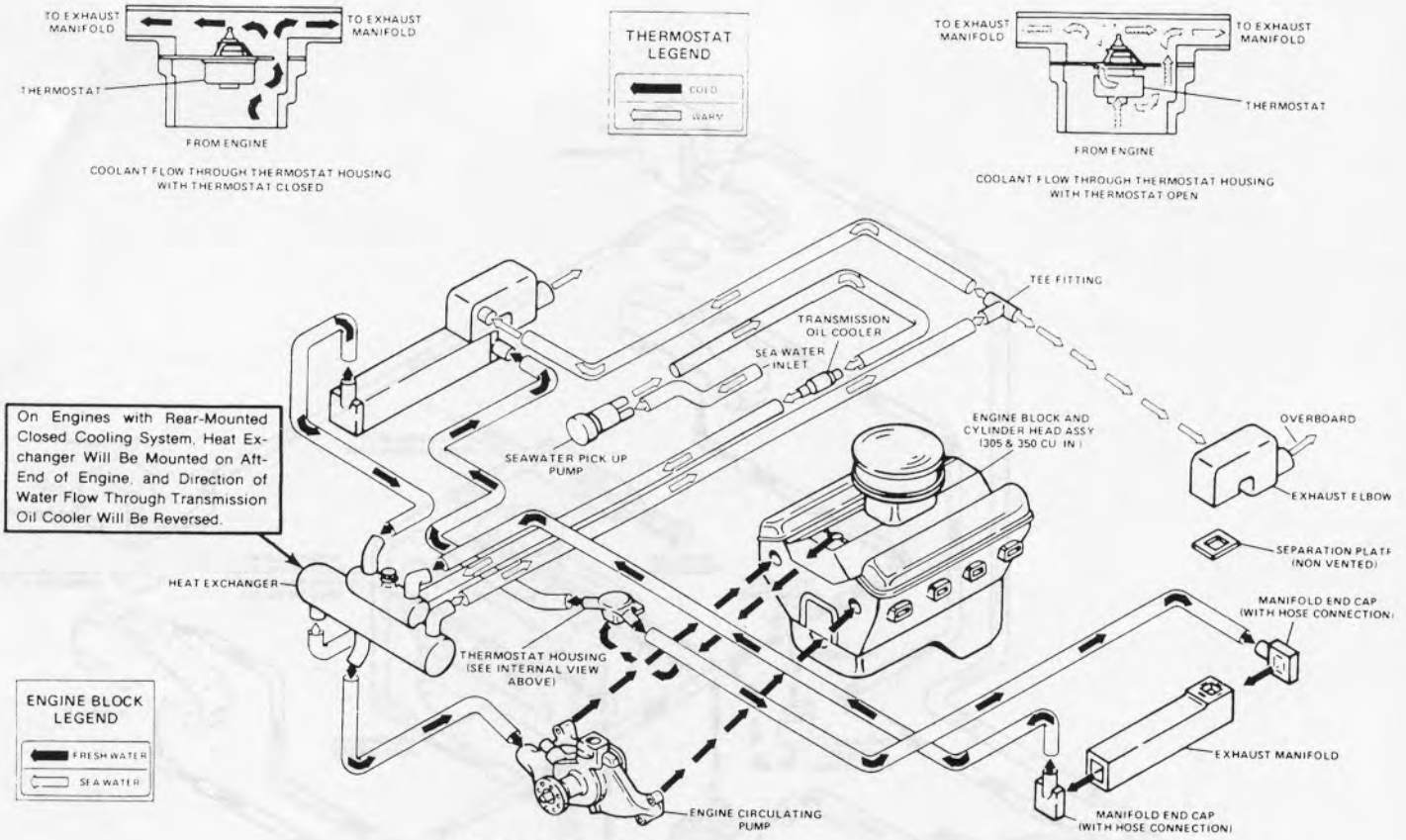


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)

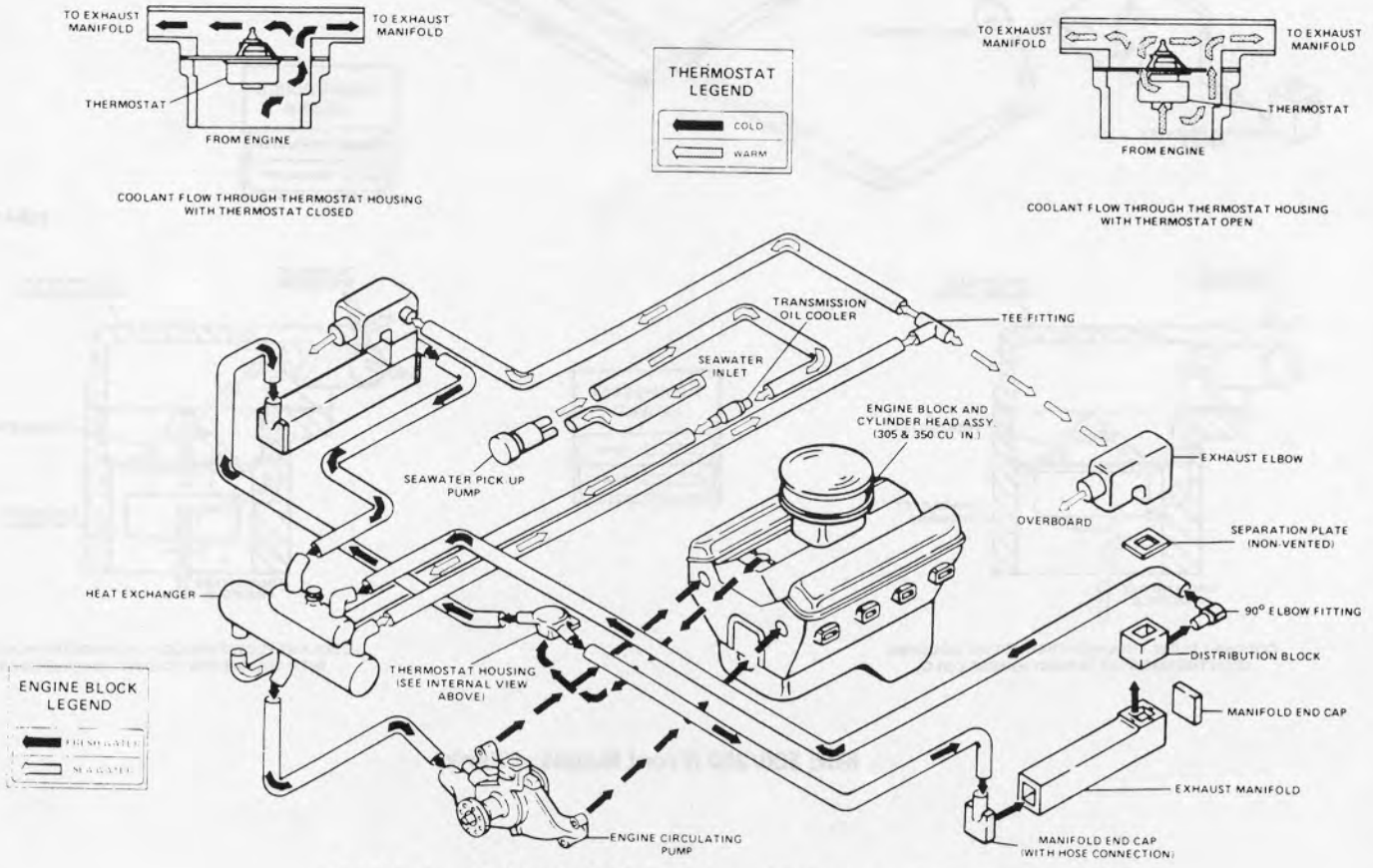
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

112-HR

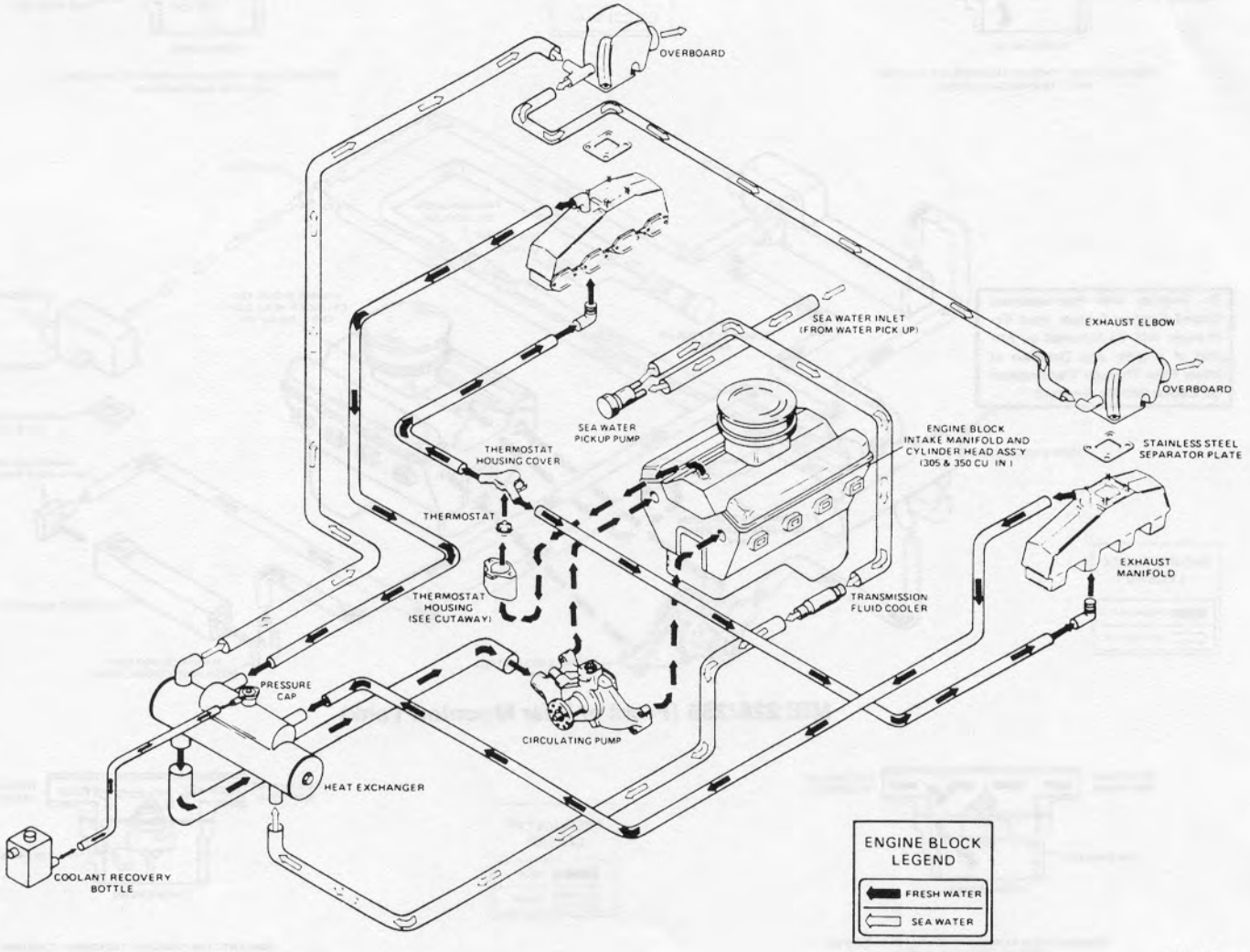
MCM 330 (B-W)



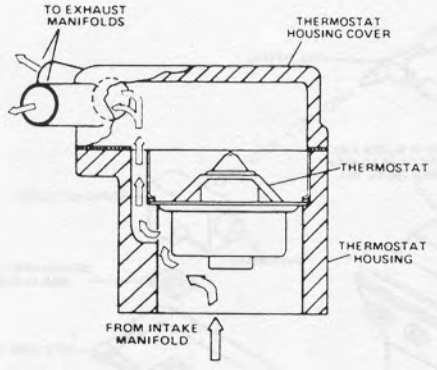
MIE 228/255 (Front or Rear Mounted Tank)



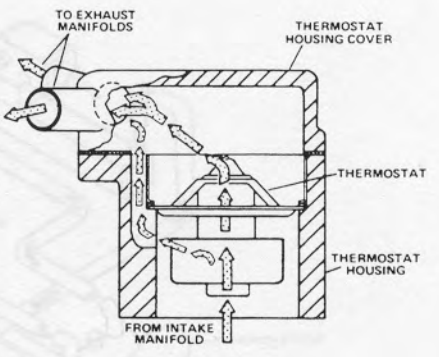
MerCruiser MIE 228/255 (V-Drive with Reversed Elbows)



243-H

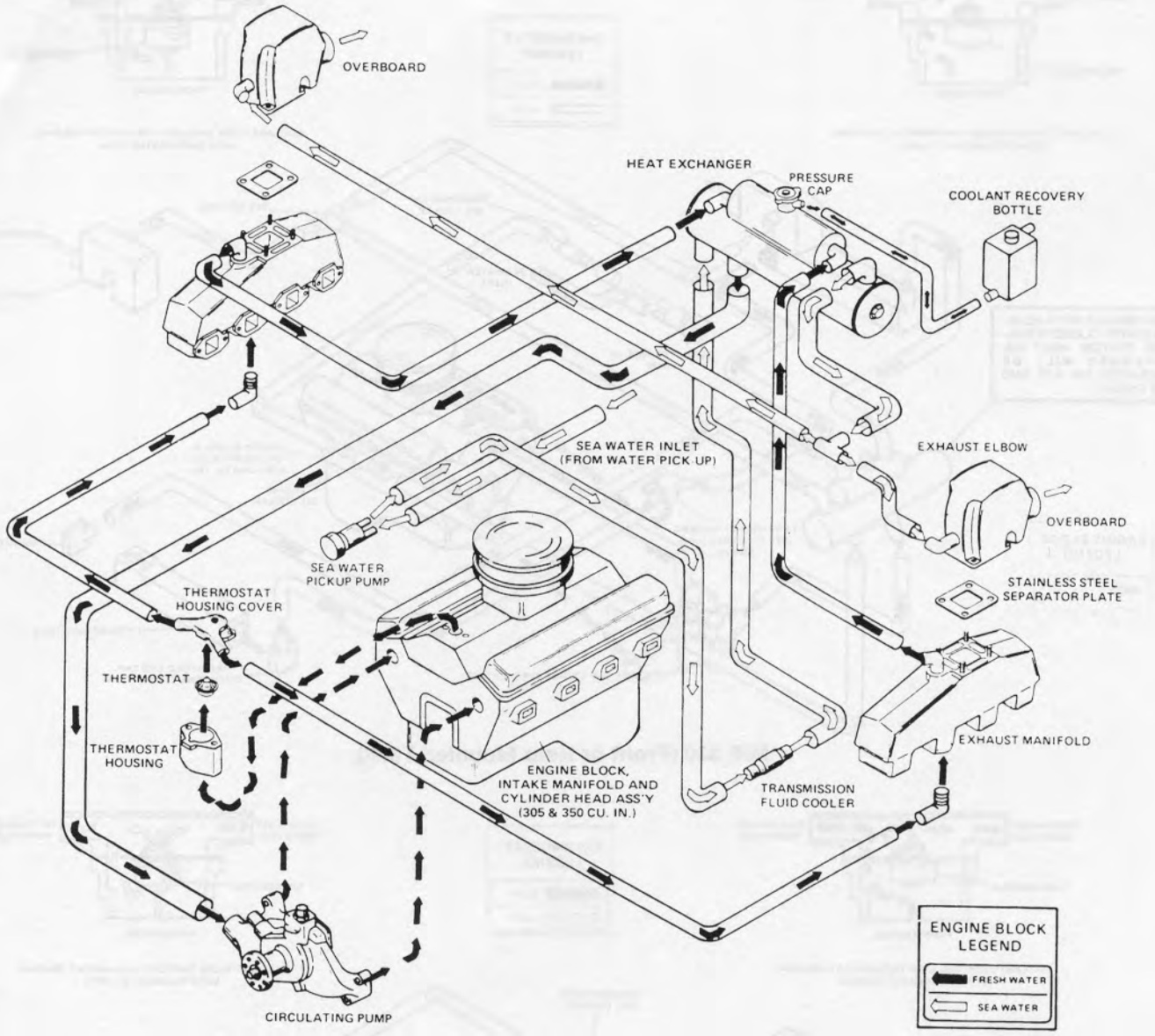


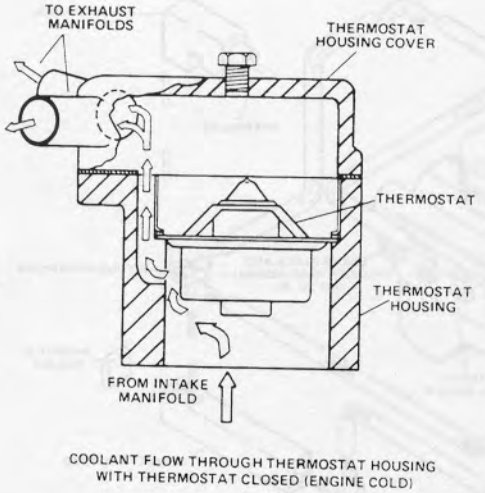
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)



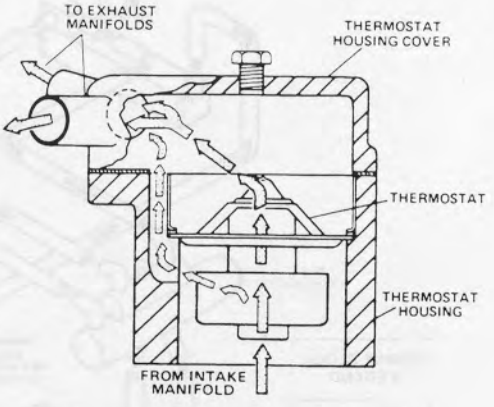
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)

MIE 230/260 (Front Mounted Tank)





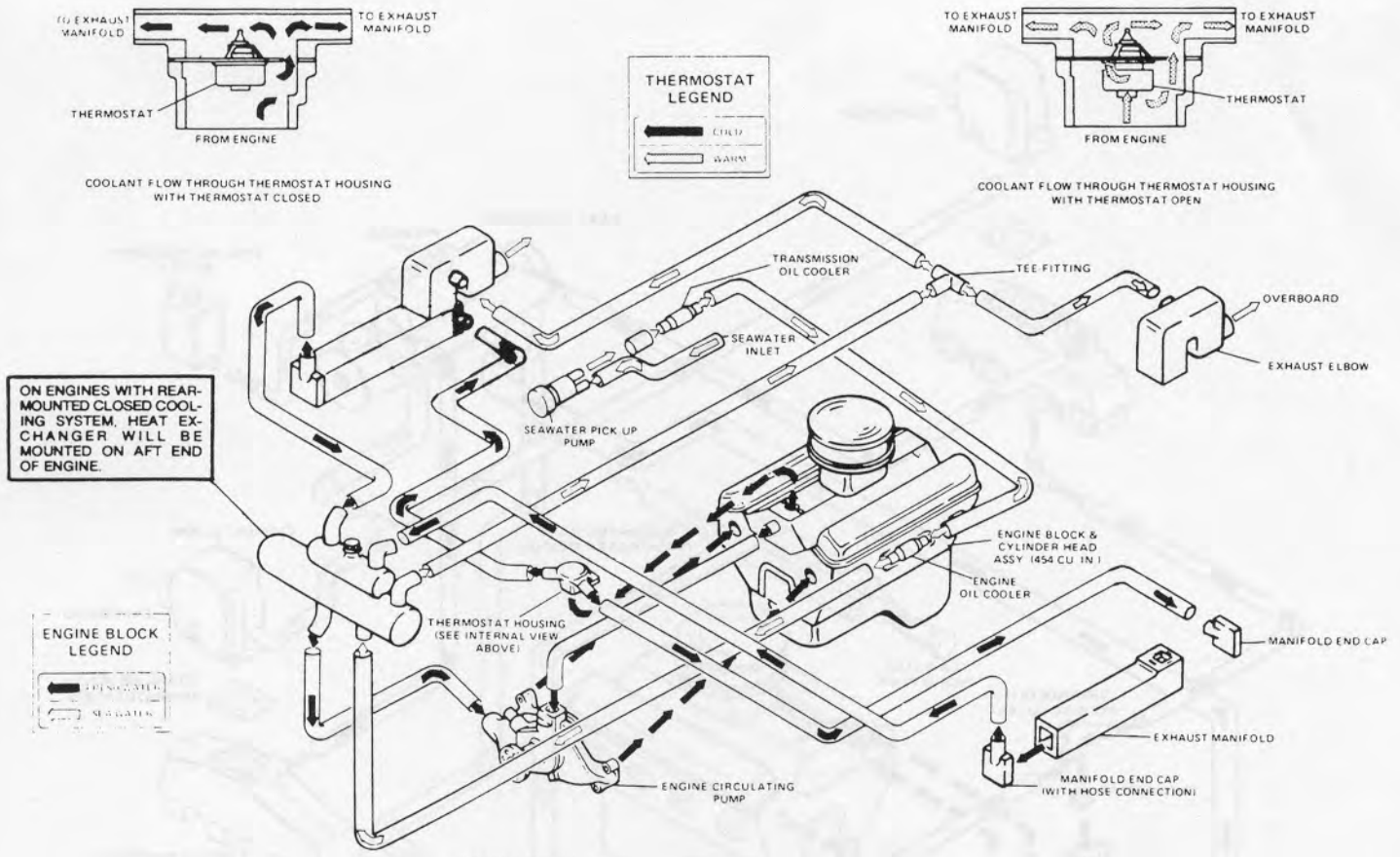
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)



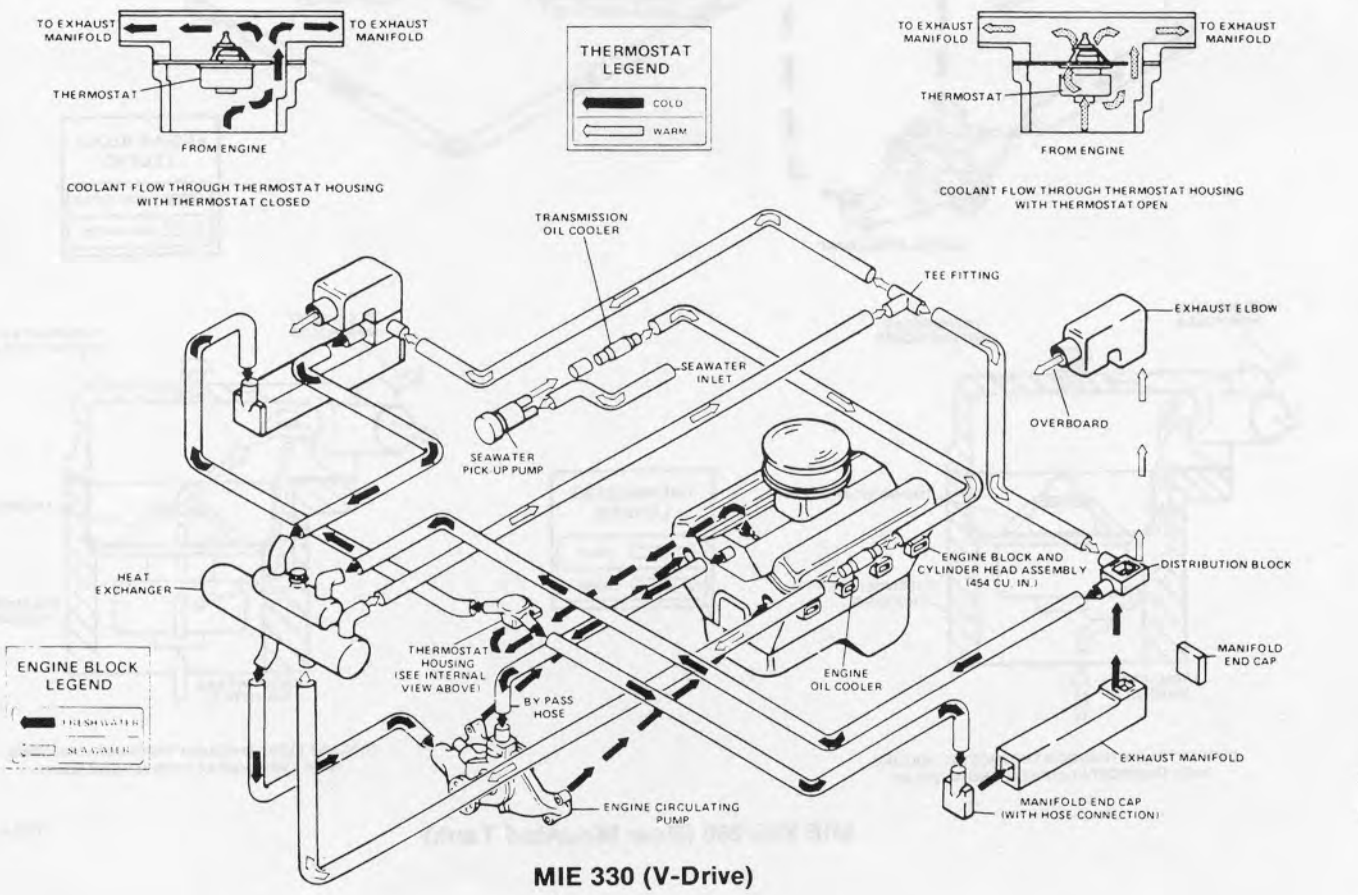
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

MIE 230/260 (Rear Mounted Tank)

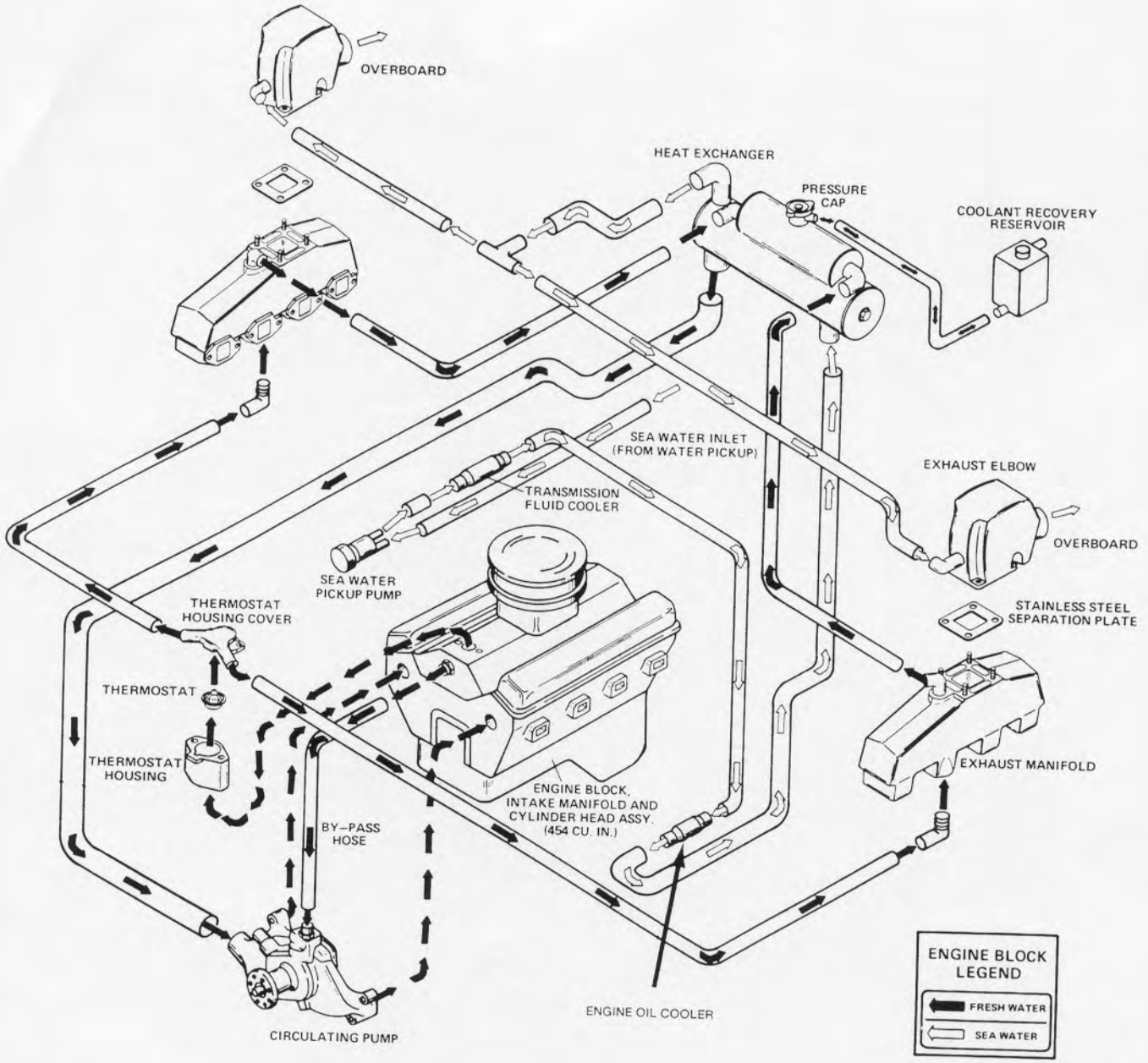
129-H

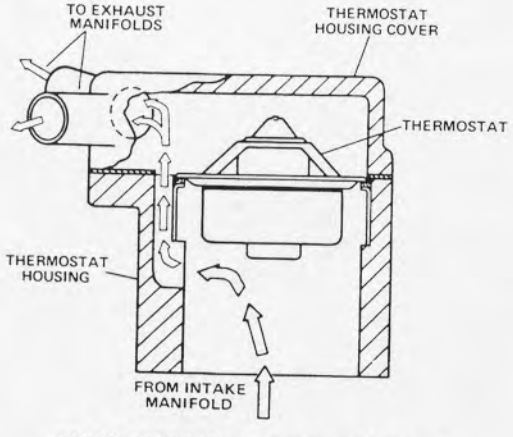


MIE 330 (Front or Rear Mounted Tank)

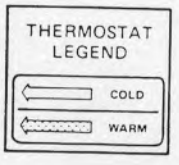


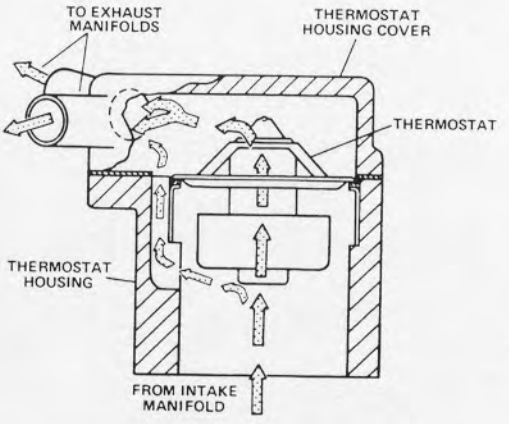
MIE 330 (V-Drive)





COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)





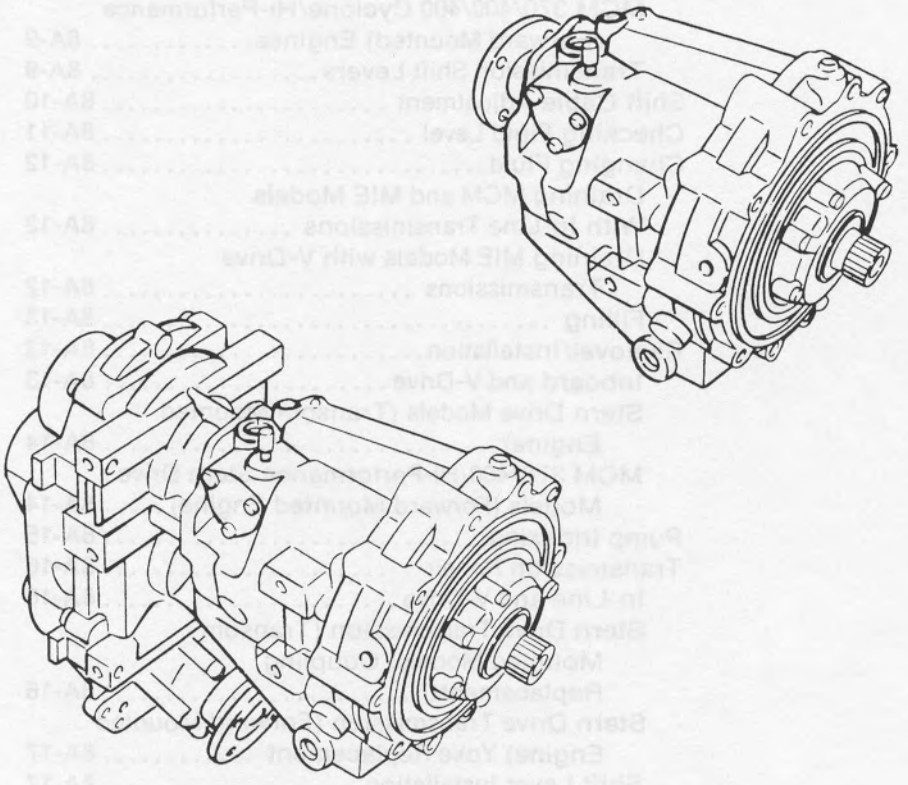
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

112-HR

MIE 340 (Rear Mounted Tank)

SECTION 8 - DRIVE SYSTEM

PART A - VELVET DRIVE ® (BORG-WARNER) TRANSMISSION



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Drain Plug (Bushing)	25 (34)	
Fluid Hose to Bushing	25 (34)	
Pump Housing to Adaptor		204-264 (23-29)
Rear Mounts to Transmission	45 (61)	
Shift Lever to Valve		96-132 (11-15)
Tailstock to Transmission (MCM Models)	50 (68)	
Transmission to Flywheel Housing	50 (68)	
Yoke to Output Shaft (MCM Forward Mounted Engine Only)	100-200 (136-271)	
Neutral Start Switch	8-11 (11-14)	

TOOLS/LUBRICANTS/SEALANTS

TOOLS/LUBRICANTS/SEALANTS	
91-34569A1	Slide Hammer Puller
92-86154A1	Quicksilver 2-4-C Multi-Lube
92-34227	Quicksilver Perfect Seal
92-32609-1	Quicksilver Loctite
92-86166	Quicksilver Bellows Adhesive
92-91601-1	Quicksilver RTV Sealer

SPECIFICATIONS

TRANSMISSION FLUID RECOMMENDATION
Dexron¾ II, Type F, and other hydraulic transmission fluids which meet the Detroit Diesel Allison Type C 3 specifications are recommended for use in all Velvet Drive¾ marine trasmissions.

TRANSMISSION FLUID CAPACITY (APPROXIMATELY)		
Engine Model	**In-Line Transmission Qts. (litres)**	**V-Drive Transmission Qts. (litres)**
MIE 470/228/ 255/330	1:1 - 2 (1.9) 1.5:1 to 1.91:1 - 3 (2.8)	4 (3.8)
MIE 230/260 340	1:1 - 2 (1.9) 1.5:1 to 2.91:1 - 3 (2.8)	4-1/2 (4.3)
MCM 330 (B-W)/ 370/400/Hi-Performance Models	2 (1.9)	

PRESSURE SPECIFICATION FOR TRANSMISSIONS USING WHITE SPRING (PART NO. 72N-242) (Note 1)				
Engine RPM	**Neutral Gear PSI (kPa)**		**Forward or Reverse Gear PSI (kPa)**	
	Min.	**Max.**	**Min.**	**Max.**
200			70 (482.6)	
500	90 (620.5)	120 (827.4)	90 (620.5)	120 (827.4)
2000			100 (689.5)	125 (861.8)

NOTE 1: Refer to "Identification" for starting serial numbers of transmissions with white spring.

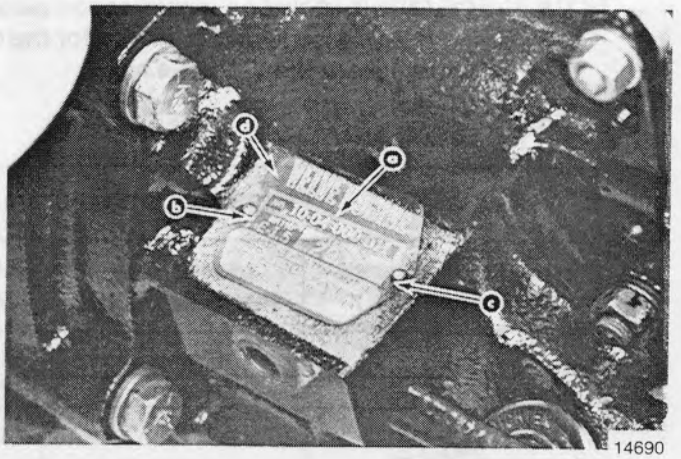
PRESSURE SPECIFICATION FOR TRANSMISSIONS USING BLACK SPRING (PART NO. 71-242)				
Engine RPM	**Neutral Gear PSI (kPa)**		**Forward or Reverse Gear PSI (kPa)**	
	Min.	**Max.**	**Min.**	**Max.**
200			70 (482.6)	
500	115 (792.9)	135 (930.8)	115 (792.9)	135 (930.8)
2000			125 (861.8)	160 (1103.2)

IN-LINE TRANSMISSION OUTPUT SHAFT ROLLING TORQUE (Note 1)		
Model	**Ratio**	**Lbs. In. (N.m)**
10-17 or 10-18	1:1	50 (68) Max.
10-17 or 10-18	1.52:1	55 (75) Max.
10-17 or 10-18	1.91:1	60 (81) Max.
10-17 or 10-18	2.57:1	65 (88) Max.
10-17 or 10-18	2.91:1	70 (95) Max.

NOTE 1: Transmission is not installed on engine, no fluid in transmission. Use torque wrench and socket on coupling nut.

IDENTIFICATION

The transmission identification plate is located on the top left side fo the transmission. (Figure 1) Refer to charts to determine engine and transmission combinations.



a - Model Number
b - Ratio (In Forward)
c - Serial Number
d - Identification Plate Model Color Code

Figure 1. Transmission Identification Plate

MIE 470/228/230/255/260 MODELS WITH IN-LINE TRANSMISSION				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Model Number**	**Old Warner Gear Model Number**	**Mercury Marine Part Number**
1:1	Red	10-17-000-004	AS1-71CBR	47805
1.52:1	Red	10-17-000-006	AS2-71CR	47806
1.91:1 (Note 2)	Red	10-17-000-008	AS7-71CR	47807
2.57:1	Red	10-17-000-012	AS14-71CR	47808
2.91:1	Red	10-17-000-014	AS15-71CR	47809

NOTE 1: This ratio is shown on indentification plate. Ratio may be rounded off in some cases.
2: The propeller shaft will turn opposite the engine rotation (when in forward gear) on this transmission.

MIE 470/228/230/255/260 MODELS WITH V-DRIVE TRANSMISSION				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Model Number**	**Assembly Numbers (Note 2)**	**Mercury Marine Part Number**
1:1	Red	10-04-000-009	10-04-410-001 (13-08-410-009)	60953
1.51:1	Red	10-04-000-011	10-04-410-001 (13-08-410-011)	60588
1.99:1	Red	1004-000-002	10-04-410-001 (13-08-410-002)	60954
2.49:1	Red	10-04-000-005	10-04-410-001 (13-08-410-005)	60955
3.14:1	Red	10-04-000-007	10-04-410-001 (13-08-410-007)	60956

NOTE 1: This ratio is shown on identification plate. Ratio may be rounded off in some cases.
2: 10-04-410-001 is the part number for the front box (forward and reverse gear). 13-08-410-_____ is the part number for the V-Drive box.

MIE 330/340 MODELS WITH IN-LINE TRANSMISSION				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Model Number**	**Old Warner Gear Model Number**	**Mercury Marine Part Number**
1:1	Green	10-18-000-002	AS11-72CR	47810
1.52:1	Green	10-18-000-004	AS12-72CR	47811
1.91:1 (Note 2)	Green	10-18-000-006	AS17-72CR	47812
2.57:1	Green	10-18-000-010	AS14-72CR	47813
2.91:1	Green	10-18-000-012	AS15-72CR	47814

NOTE 1: This ratio is shown on identification plate. Ratio may be rounded off in some cases.
2. The propeller shaft will turn opposite the engine rotation (when in forward gear) on this transmission.

MIE 330/340 MODELS WITH V-DRIVE TRANSMISSION				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Number**	**Assembly Numbers (Note 2)**	**Mercury Marine Part Number**
1:1	Green	10-05-000-009	10-05-410-001 (13-08-410-009)	60958
1.51:1	Green	10-05-000-011	10-05-410-001 (13-08-410-011)	60959
1.99:1	Green	10-05-000-002	10-05-410-001 (13-08-410-002)	60960
2.49:1	Green	10-05-000-005	10-05-410-001 (13-08-410-005)	60961
3.14:1	Green	10-05-000-007	10-05-410-001 (13-08-410-007)	60962

NOTE 1: This ratio is shown on identification plate. Ratio may be rounded off in some cases.
2: 10-05-410-001 is the part number for the front box (forward and reverse gear). 13-08-410-_____ is the part number for the V-Drive box.

MCM 330 (B-W)/370/400/400 CYCLONE/440 CYCLONE/460 CYCLONE/475 TURBO ENGINES USED ON STERN DRIVE MODELS				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Model Number**	**Old Warner Gear Model Number**	**Mercury Marine Part Number**
1:1	Green	10-18-000-014	AS20-72CR	47754A9
1:1 (Note 2)	Red	10-17-000-016	AS20-71CR	47753

NOTE 1: This ratio is shown on identication plate. Ratio may be rounded off in some cases.
2: MCM 330 (B-W) S.N 670343 and above use this transmission.

IN-LINE TRANSMISSIONS

PART NUMBER 72N-242 WHITE PRESSURE REGULATOR VALVE SPRING USED (NOTE 1)		
Ratio In Forward Gear	**Warner Gear Model Number**	**Starting Serial Number and Above**
1:1	10-17-000-004	241
1.52:1	10-17-000-006	3767
1.91:1	10-17-000-008	3697
2.57:1	10-17-000-012	1904
2.91:1	10-17-000-014	2708
1:1 (Note 2)	10-17-000-016	143
1:1	10-18-000-002	2152
1.52:1	10-18-000-004	2023
1.91:1	10-18-000-006	2880
2.57:1	10-18-000-010	829
2.91:1	10-18-000-012	1282
1:1 (Note 3)	10-18-000-014	2784

NOTES 1: Sealing rings (instead of bushings) used in these transmissions also.
2: MCM 330 (B-W) (S.N. 670343 and above) only.
3: MCM 330 (B-W) (S.N.6760342 and below) and all Hi-Performance Stern Drive Models.

V-DRIVE TRANSMISSIONS

PART NUMBER 72N-242 WHITE PRESSURE REGULATOR VALVE SPRING USED (NOTE 1)		
Ratio In Forward Gear	**Warner Gear Model Number**	**Starting Serial Number and Above**
1:1	10-04-000-009	1069
1.51:1	10-04-000-011	2111
1.99:1	10-04-000-002	3172
2.49:1	10-04-000-005	463
3.14:1	10-04-000-007	480
1:1	10-05-000-009	703
1.51:1	10-05-000-011	153-156, 643-683, 1200
1.99:1	10-05-000-002	1108
2.49:1	10-05-000-005	340-347, 354
3.14:1	10-05-000-007	314

NOTES 1: Sealing rings (instead of bushings) used in these transmissions also.

IMPORTANT INFORMATION

SHIFT CONTROL and CABLES

⚠CAUTION

Shift control and shift cable MUST position transmission shift lever EXACTLY as stated in this manual, or transmission as a result of improper shift lever positioning will not be covered by Warner Gear Warranty.

IMPORTANT: Warner Gear Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner.

Remote control used must position transmission shift lever over the letter "F" embossed on transmission case when remote control is placed in forward gear position. Transmission failure will occur if transmission shift lever is positioned over the letter "R" and the wrong rotation propeller is used to propel boat forward.

Remote control also must provide a total shift cable travel (at transmission end) of at least 2¾" (70mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.

ENGINE

Engine rotation is indicated on engine specifications and serial number decal on rocker arm cover. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

Installed angle of MIE inboard transmission and engine should not exceed a maximum of 18° of the water line.

TRANSMISSION

Transmission gear ratio (in forward gear) is marked on transmission identification plate, which is located on the port (left) side of transmission. Transmission output shaft rotation and propeller rotation required is indicated on a decal on transmission case. Transmission rotation is described when viewed from the rear of transmission with transmission in forward gear selector position.

On MIE engines which are equipped with in-line transmissions have 1:1, 1.5:1, 2.5:1 or 3:1 gear ratios, transmission output shaft rotation is the same as engine rotation with transmission in forward gear. If engine rotation is "LH" (CCW), a "LH" propleller is required. If engine rotation if "RH" (CW), a "RH" propeller is required.

On MIE engines which are equipped with in-line transmissions having 2:1 gear ratio, transmission output shaft rotation is opposite of engine rotation with transmission in forward gear. If engine rotation is "LH" (CCW), a "RH" propeller is required. If engine rotation is "RH" (CW), a "LH" propeller is required.

ON MIE engines which are equipped with V-drive transmissions, transmission output shaft rotation is the same as engine rotation with transmission in forward gear. Because of reversed engine mounting position, however, a "RH" propeller is requied, if engine is "LH" (CCW) rotation; or "LH" rotation propeller is required, if engine is "RH" (CW) rotation.

1. DO NOT start or crank engine without fluid in transmission.
2. Use only recommended fluid in transmission.
3. Except in an emergency, never shift transmission at engine speeds above 1000 RPM.
4. Free wheeling of one propeller (of a twin engine boat) at trolling speeds will not cause damage to the transmission, however, boat operation above trolling speed should be avoided. Be sure proper fluid level exists before free wheeling propeller.
5. DO NOT paint shift lever poppet ball and spring. An accumulation of paint here will prevent proper action of the detent.
6. Always replace oil cooler and hoses after a transmission failure, prior to installing a new or rebuilt transmission. Metallic particles from the failure tend to collect in the cooler and hoses and will gradually flow back into the lube system and damage transmission.
7. Always use specified oil cooler, hoses and fittings. Hoses must be at least 13/32" (10.3mm) I.D. Oil cooler, hoses and fittings must be sufficient size to maintain transmission fluid (in sump) at 140° - 190° F (60° - 88° C).

PROPELLER

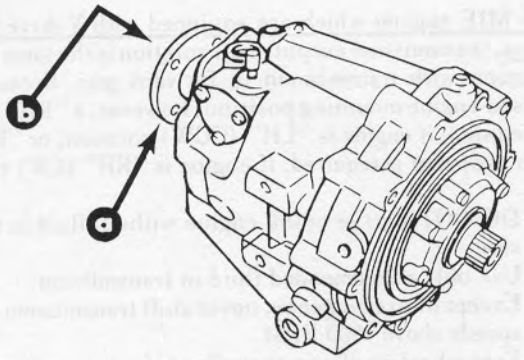
Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow end). The term "left-hand" ("LH") refers to rotation in the counterclockwise (CCW) direction. The term "right-hand" ("RH") refers to rotation in the clockwise (CW) direction. A "LH" propeller will move the boat forward when rotated counterclockwise. A "RH" propeller will move the boat forward when rotated clockwise. PROPELLER ROTATION IS NOT NECESSARILY THE SAME AS ENGINE ROTATION.

SPECIAL REPLACEMENT PART INFORMATION

MCM 330 (B-W) and MCM 370/400/ 400 CYCLONE/HI-PERFORMANCE (TRANSOM MOUNTED) ENGINES

The standard inboard 1:1 transmission (10-18 or 10-17) has a Pinion Cage and Output Shaft that is threaded so the coupling can be held on with a nut. (Figure 1)

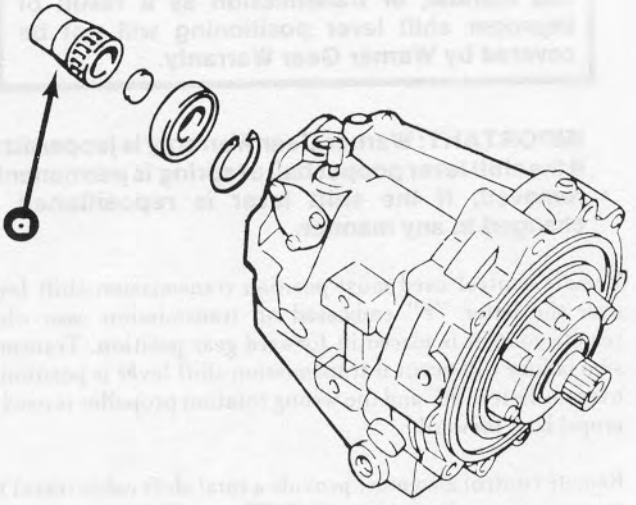
On these stern drive applications, Warner Gear installs a Pinion Cage and Output Shaft that is splined so that a splined coupling can be used. (Figure 2)



a - Flanged Coupling
b - Nut (Hidden)

Figure 1. Standard Inboard Transmission

This special Pinion Cage and Output Shaft is not shown in Warner Gear parts lists at this time. Refer to chart for Warner Gear part number when ordering new part. Refer to MerCruiser parts list for ordering splined coupling, plug, bearing and snap ring shown in Figure 2.



a - Splined Coupling

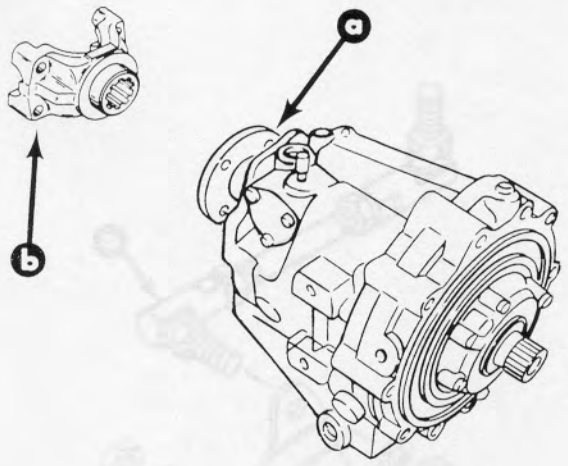
Figure 2. Special Stern Drive Transmission

WARNER GEAR PART NUMBERS FOR SPECIAL PINION CAGE AND OUTPUT SHAFT

Transmission Model Number	When Bushings Are Used	When Sealing Rings Are Used
10-18-000-014	10-18-659-002	10-18-659-014
10-17-000-016	10-17-659-002	10-17-659-020

MCM 370/400/400 CYCLONE/HI-PERFORMANCE (FORWARD MOUNTED) ENGINES

The flanged coupling is removed from the standard 1:1 transmission (10-18). A yoke as installed so that the drive shaft can be bolted to the output shaft of the transmission. (Figure 3) Part number for yoke is in MerCruiser parts lists.



a - Remove Falnge Coupling
b - Install Yoke for Drive Shaft

Figure 3. Transmission with Yoke

TRANSMISSION SHIFT LEVERS

Different shift levers have been used on Borg-Warner transmissions installed on MerCruisers. Refer to chart for usage.

Model	Shift Lever
MCM 330 (B-W) MIE 230/260/340	Figure 4
MCM 370/Hi-Performance With Reverse Lock Valve	Figure 5
MCM 370 S.N. 5670317-6721142	Figure 6
MCM 400 Cyclone S.N. 6844266 and Below	Figure 6
MCM 370 S.N. 6721143 and Above	Figure 7
MCM 400 Cyclone S.N. 6844267 and Above	Figure 7
MIE 228/255/330	Figure 8

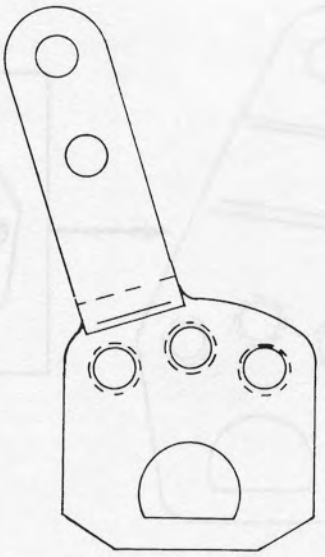


Figure 4. 43325 Lever

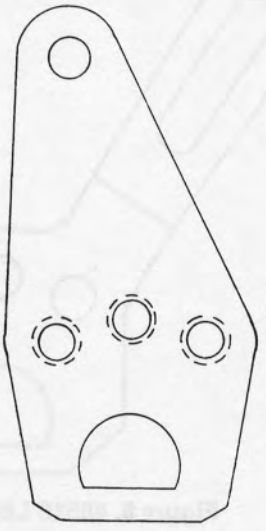


Figure 5. 47472 Lever (Lever Is Not Bent)

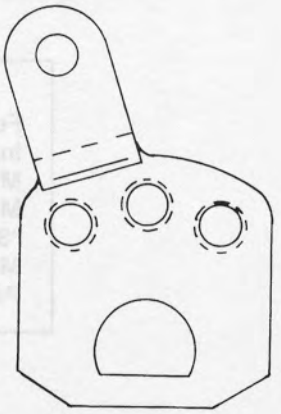


Figure 6. 41328 Lever

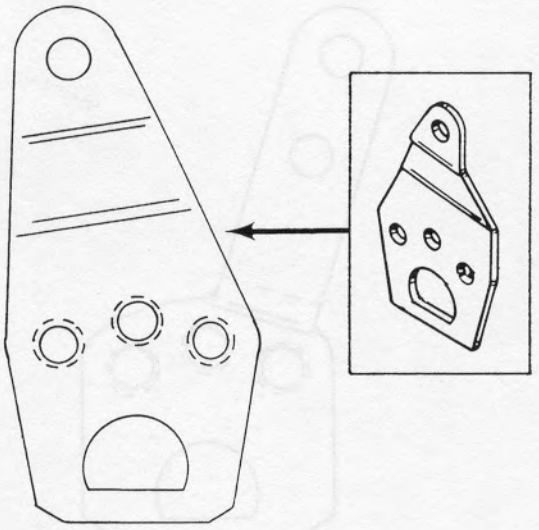


Figure 7. 12128 Lever

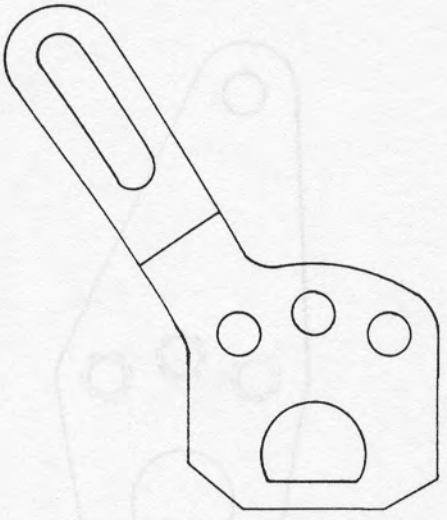
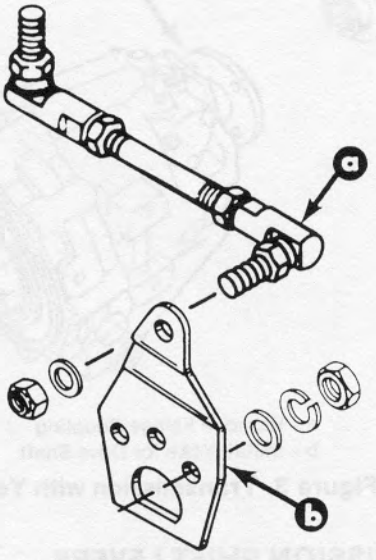


Figure 8. 48515 Lever

MCM 370/HI-PERFORMANCE MODELS WITHOUT REVERSE LOCK VALVE

A new shift lever (P.N. 12128) enables the use of any Quicksilver Remote Control. With the old lever (P.N. 41328), only the Quicksilver Two-Lever Remote Control could be used. The new shift lever can be used on engines that had the 41328 lever. Turn end of link rod 180° (as shown in Figure 9) to allow connection to new lever.



a - End of Link Rod Turned 180°
b - 12128 Shift Lever

Figure 9.

SHIFT CABLE ADJUSTMENT

NOTICE
For shift cable adjustment, refer to the following:
MCM 330 (B-W) TR/TRS: "Section 2, Part G".
MCM 370/400 and Hi-Performance Models: "Section 2, Part H".
MIE 470/228/230/255/260/330/340: "Section 2, Part I".

CHECKING FLUID LEVEL

IMPORTANT: Use only fluid recommended in "Specifications".

Transmission fluid should be checked when starting engine each day, as follows: (Figure 1)

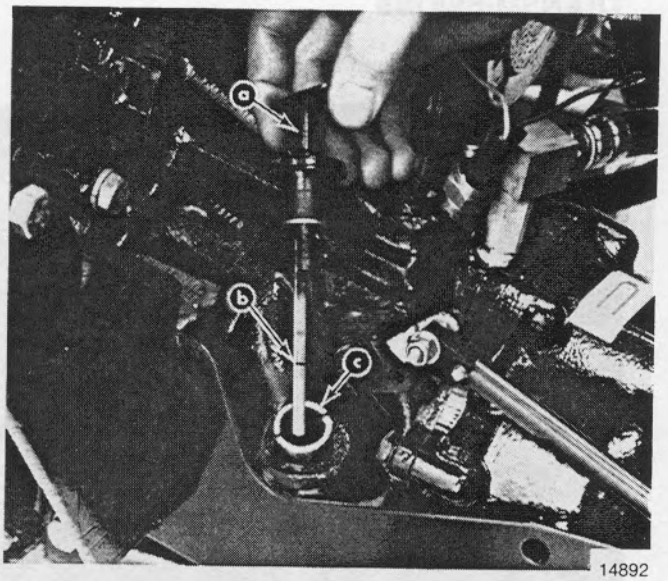
1. Remove dipstick. Check to ensure that fluid is indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add automatic transmission fluid (ATF) until level comes up to full mark on dipstick.

   IMPORTANT: To accurately check fluid level, engine MUST BE run at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

   IMPORTANT: Be sure to push dipstick all-the-way down into dipstick tube when checking fluid level.

3. Stop engine and QUICKLY check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick.
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.



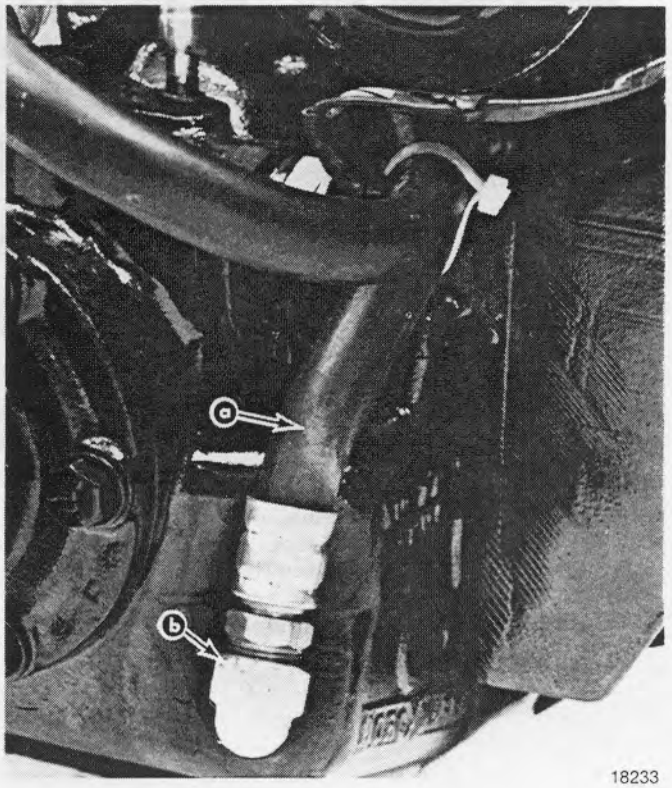
a - Dipstick
b - Full Mark
c - Dipstick Tube

Figure 1. Checking Transmission Fluid Level

CHANGING FLUID

DRAINING MCM and MIE MODELS with IN-LINE TRANSMISSIONS

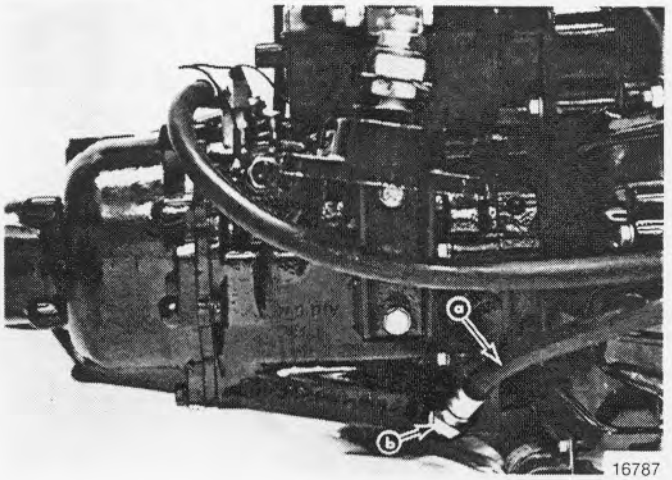
1. Disconnect hose from bushing: (Figure 1 or 2)



18233

a - Hose
b - Bushing

Figure 1. MIE 10-17 Transmission 1:1 Ratio Only

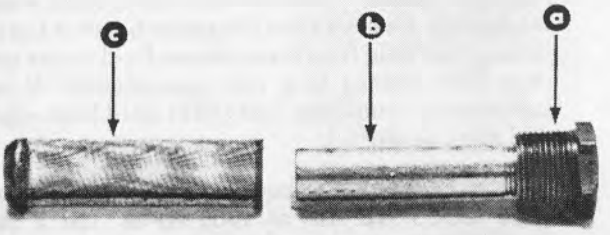


16787

a - Hose
b - Bushing

Figure 2. 10-18 Transmission 1:1 Ratio, All Transmissions with Reduction Gear and All MCM Transmissions

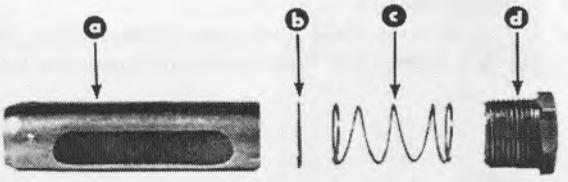
2. Remove bushing to drain. (Figure 1 or 2)
3. If bushing has strainer, clean strainer.
4. After transmission has drained completely, refer to Figures 3 and 4.



18388

a - Bushing
b - Charge Tube (Not Used on All Models)
c - Strainer [Installed approximately 1/2" (13mm) Below Surface of Case]

Figure 3. Models with Strainer



18389

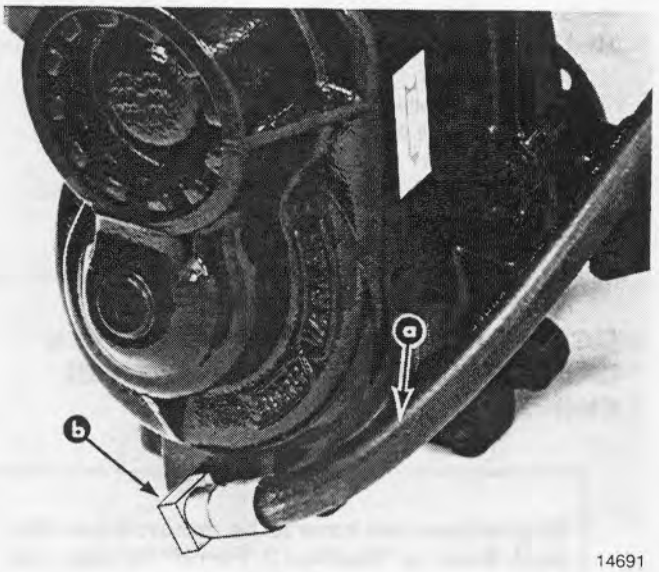
a - Oil Shield (Slot Toward Bottom of Transmission)
b - Washer
c - Spring
d - Bushing

Figure 4. Models with Oil Shield

5. Coat threads of bushing with Perfect Seal and install into transmission in order shown in Figure 3 or 4. Torque to specifications.
6. Reconnect hose and tighten fitting securely.
7. Refer to "Filling".

DRAINING MIE MODELS WITH V-DRIVE TRANSMISSIONS

1. Disconnect hose from bushing. (Figure 5)
2. Remove bushing to drain (Figure 5)



a - Hose
b - Busing

Figure 5. V-Drive Transmission

3. After transmission has drained completely, coat threads of bushing with Perfect Seal and install into transmission. Torque to specifications.
4. Reconnect hose and tighten fitting securely.
5. Refer to "Filling".

FILLING

IMPORTANT: Use only fluid recommended in "Specifications".

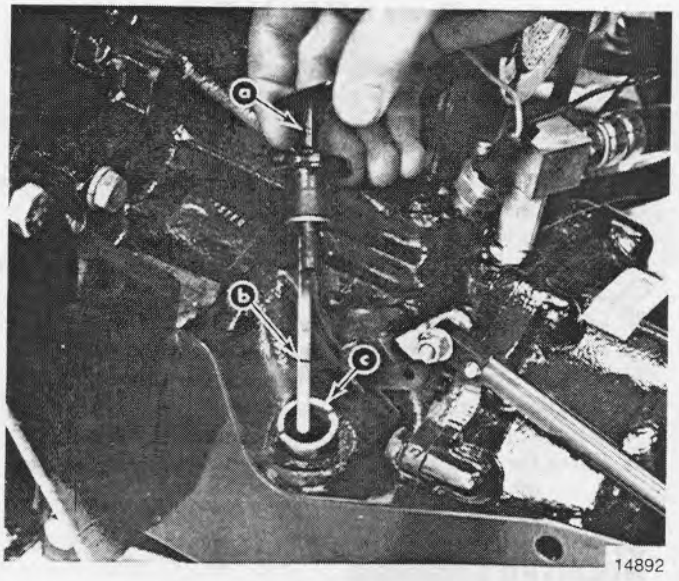
1. Remove dipstick and fill with transmission fluid until level comes up to full mark. (Figure 6)

IMPORTANT: To accurately check fluid level, engine MUST BE run at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic curcuits.

   NOTE: Be sure to push dipstick all-the-way down into dipstick tube when checking fluid level.

3. Stop engine and QUICKLY check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick. Be sure to tighten "T" handle securely.



a - Dipstick
b - Full Mark
c - Dipstick Tube

Figure 6. Checking Transmission Fluid Level

REMOVAL/INSTALLATION

INBOARD AND V-DRIVE

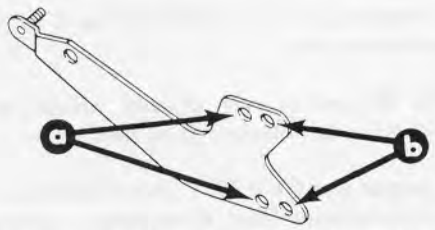
NOTICE
The following procedure describes removal of transmission without removing engine. If engine must be removed, refer to "Section 2, Part I"

1. Drain transmission fluid.
2. Disconnect fluid cooler hoses.
3. Disconnect shift cable.
4. Disconnect wires from neutral start safety switch.
5. **Models With Audio Warning System:** Disconnect wire from fluid temperature switch.
6. Disconnect propeller shaft coupling.
7. Remove 4 rear mount (to engine bed) bolts.
8. Support rear part of engine with either a hoist or by using wooden blocks under flywheel housing.
9. Remove 2 center transmission to flywheel housing attaching bolts and install 2 long studs.

IMPORTANT: These 2 long studs will help support weight of transmission during removal and installation.

10. Remove remaining transmission attaching bolts.
11. Pull transmission straight back and off engine.
12. Before installing transmission, check transmission pump indexing for correct rotation. Refer to "Pump Indexing".
13. **In-Line Transmissions Only:** Check transmission output shaft rolling torque. See "Specifications".
14. Apply 2-4-C Multi-Lube to transmission input shaft splines and engine drive plate splines.
15. If removed, install rear engine mounting brackets (to transmission) as outlined in "Section 6, Part B or C". Torque to specifications.

IMPORTANT: MIE 230/260/340 Only: If transmission has shift cable anchor plate 93141A7, refer to Figure 1.



a - Use these Mounting Holes on MIE 230/260
b - Use these Mounting Holes on MIE 340

Figure 1. 93141A7 Plate

16. Align transmission splines with drive plate splines.
17. Slide transmission into place and secure with bolts.
18. Remove 2 long studs (installed in step 8) and install remaining 2 bolts. Torque all bolts to specifications.
19. Relieve hoist tension and fasten rear engine mounts to engine bed. Tighten bolts secuely.
20. Connect wires to neutral start safety switch.
21. **Models With Audio Warning System:** Connect tan/blue wire to fluid temperature switch.
22. Connect fluid cooler hoses to transmission.
23. Refill (or check) transmission as outlined.
24. Refer to "Section 2, Part I" for the following:
    - Alignment.
    - Shift cable attachment and adjustment.
25. Check for leaks and fluid level after first engine start up.

STERN DRIVE MODELS (TRANSOM MOUNTED ENGINES)

NOTICE
Refer to "Section 2, Part G or H" for engine removal and installation.

1. Remove engine as outlined.
2. Drain transmission fluid.
3. Disconnect fluid cooler hoses.
4. Disconnect wires from neutral start safety switch.
5. **Models With Audio Warning System:** Disconnect wire from fluid temperature switch.
6. Remove 2 center transmission to flywheel housing attaching bolts and install 2 long studs.

IMPORTANT: These 2 long studs will help suport weight off transmission during removal and installation.

7. Remove remaining transmission attaching bolts.
8. Pull transmission straight back and off engine.
9. Before installing transmision, check transmission pump indexing for correct rotation. Refer to "Pump Indexing.
10. If removed, install transmission side brackets. Torque bolts to specifications.
11. Apply 2-4-C Multi-Lube to transmission input shaft splines and engine drive plate splines.
12. Align transmission splines with drive plate splines.
13. Slide transmission into place and secure with bolts.
14. Remove 2 long studs (installed in step 5) and install remaining 2 bolts. Torque all bolts to specifications.
15. Connect wires to neutral start safety switch.
16. **Models With Audio Warning System:** Connect tan/blue wire to fluid temperature switch.
17. Connect fluid cooler hoses to transmission.
18. Reinstall engine as outlined.
19. Refill (or check) transmission as outlined.
20. Refer to "Section 2, Part G or H" for the following:
    - Alignment.
    - Shift cable attachment and adjustment.
21. Check for leaks and fluid level after first engine start up.

MCM 370/400/HI-PERFORMANCE STERN DRIVE MODELS (FORWARD MOUNTED ENGINE)

NOTICE
Engine does not have to be removed from the boat. Refer to "Section 2, Part H" for step that have number underlined, 5, 6 etc.

1. Drain transmission fluid.
2. Disconnect fluid cooler hoses.
3. Disconnect shift cable.
4. Disconnect wire from neutral start safety switch.
5. Disconnect Power Trim hoses from reverse lock valve (some models).

⚠CAUTION
Drive shaft has been assembled and balanced at the factory with the universal joint yokes (on both ends of shaft) running in the same plane. Refer to "Section 2, Part H" BEFORE proceeding.

6. Disconnect driveshaft from transmission as outlined.
7. Remove 2 center transmission to flywheel housing attaching bolts and install 2 long studs.

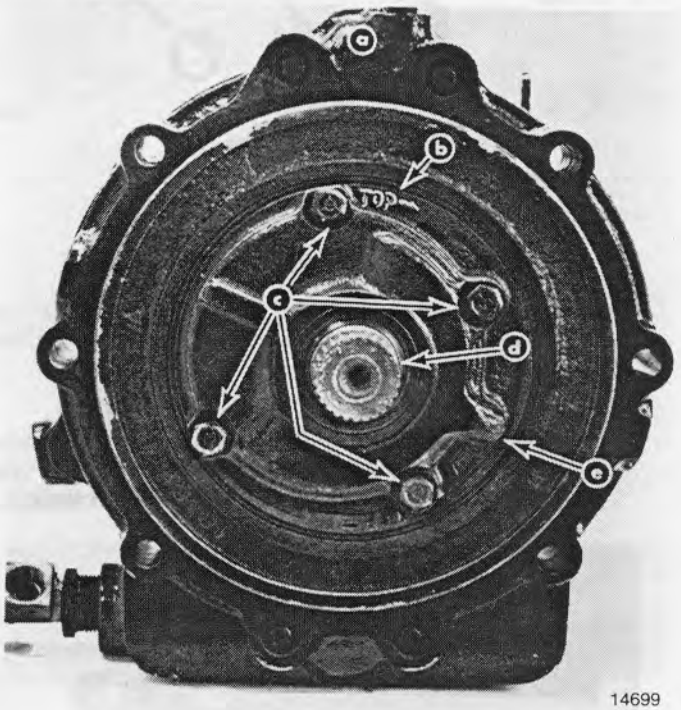
IMPORTANT: These 2 long studs will help support weight of transmission during removal and installation.

8. Remove remaining transmission attaching bolts.
9. Pull transmission straight back and off engine.
10. Before installing transmission, check transmission pump indexing, for correct rotation. Refer to "Pump Indexing".
11. Apply 2-4-C Multi-Lube to transmission input shaft splines and engine drive plate splines.
12. Align transmission splines with drive plate splines.
13. Slide transmission into place and secure with bolts.
14. Remove 2 long studs (installed in step 7) and install remaining 2 bolts. Torque all bolts to specifications.
15. Conect wires to neutral start safety switch.
16. Connect fluid cooler hoses to transmission.
17. Reconnect drive shaft to transmission as outlined.
18. Reconnect Power Trim hoses to reverse lock valve (some models).
19. Refill (or check) transmission as outlined.
20. Refer to "Section 2, Part H" for the following:
    - Alignment.
    - Shift Cable attachment and adjustment.
21. Check for leaks and fluid level after first engine start up.

PUMP INDEXING

Pump must be correctly indexed to correspond with engine rotation. If pump is not indexed correctly, pump will not create oil pressure and transmission will not shift. Pump housing has two arrows, each pointing in a different direction. Pump must be positioned so that the arrow (pointing in the direction that input shaft and pump will be turned by engine) is at the top of transmission. Refer to Figure 1 or 2 for correct pump indexing.

IMPORTANT: Some transmissions have the letters "R.H." and "L.H." on pump housing. Letters DO NOT indicate engine rotation.



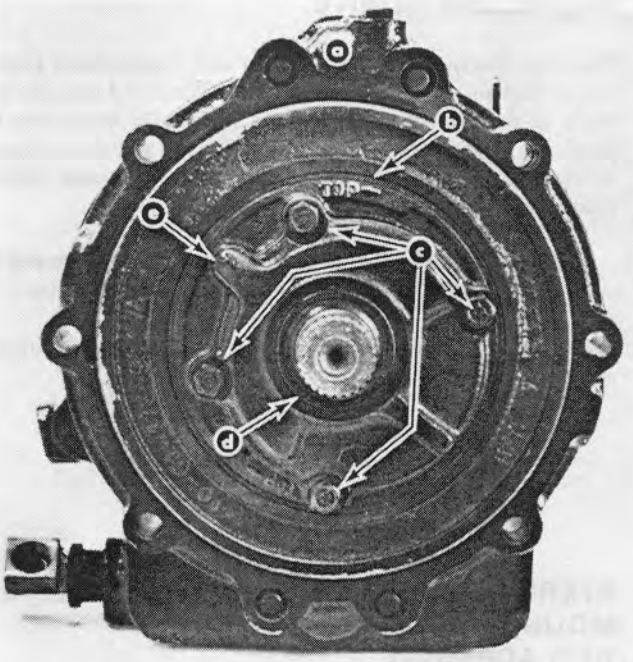
14699

a - Top of Transmission
b - Top → (or Top R.H.)
c - Pump Attaching Bolts
d - Input Shaft
e - Fluid Passage Boss

Figure 1. MCM and MIE L.H. (STANDARD) ROTATION ENGINES

If pump must be reindexed, proceed as follows (Figure 1 or 2):

1. Remove 4 pump attaching bolts.
2. Loosen the pump housing. A soft tip mallet may be used to tap the fluid passage boss. DO NOT strike the bolt bosses.



14700

a - Top of Transmission
b - Top ← (or Top L.H.)
c - Pump Attaching Bolts
d - Input Shaft
e - Fluid Passage Boss

Figure 2. MIE R.H. (Opposite) Rotation Engines

IMPORTANT: DO NOT remove the pump from the shaft unless a seal protector is used to prevent the shaft splines from cutting the pump seal. Care must be taken to ensure that seal, gasket, seal and bolt bosses are kept in good condition to prevent leaks in those critical areas.

4. Make sure that pump gasket is not sticking to housing (to prevent gasket from tearing or folding) when rotating pump.
5. Rotate pump until arrow indicating the proper direction of pump rotation is near the top of transmission.
6. Reinstall 4 pump to adaptor attaching bolts and torque to specifications.

IN-LINE and V-DRIVE

Mercury Marine does not stock or sell replacement parts for the in-line or V-drive transmission. Warner Gear has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals (for each transmission) can be obtained from Warner Gear.

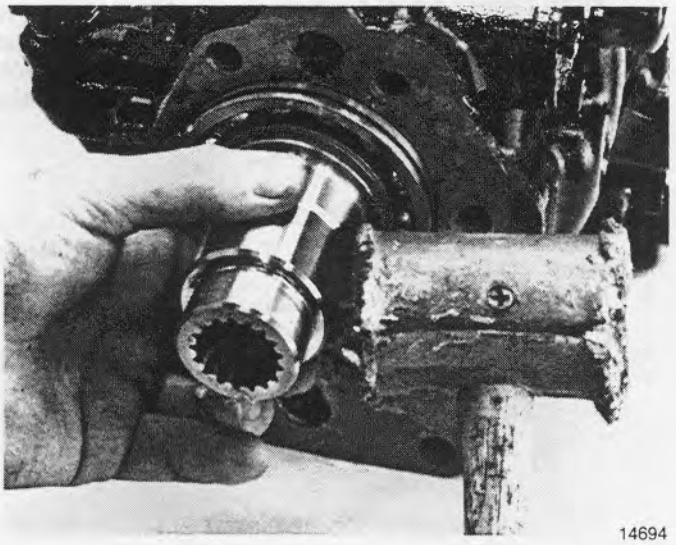
IMPORTANT: Refer to "Special Replacement Part Information" before working on transmission.

For the location of your closed distributor or service literautre contact:

Warner Gear
Marketing Communications
P.O. Box 2688
Muncie, IN. 47302 U.S.A.

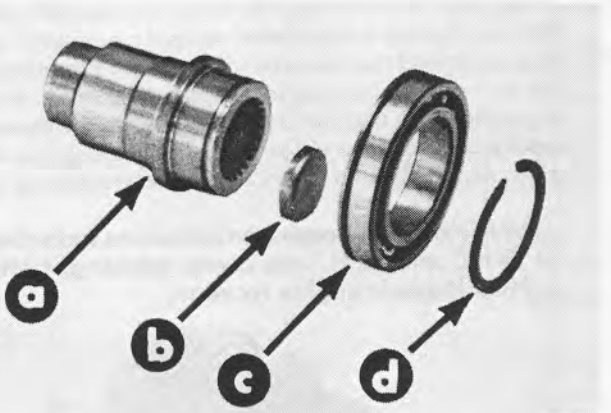
STERN DRIVE TRANSMISSION (TRANSOM MOUNTED MODELS) COUPLING REPLACEMENT

1. Remove tailstock assembly as outlined.
2. Tap coupling assembly with a soft-tip mallet while pulling to remove. (Figure 1)
3. Remove snap ring from coupling and press coupling from ball bearing. (Figure 2)
4. Drive expansion plug out transmission end of coupling.
5. Inspect and clean all parts. Replace any worn parts.
6. Apply a thin coat of Loctite "A" to outer diameter of new expansion plug. Press plug into coupling (with cupped side away from transmission) until it bottoms out.



14694

Figure 1. Removing Coupling Assembly



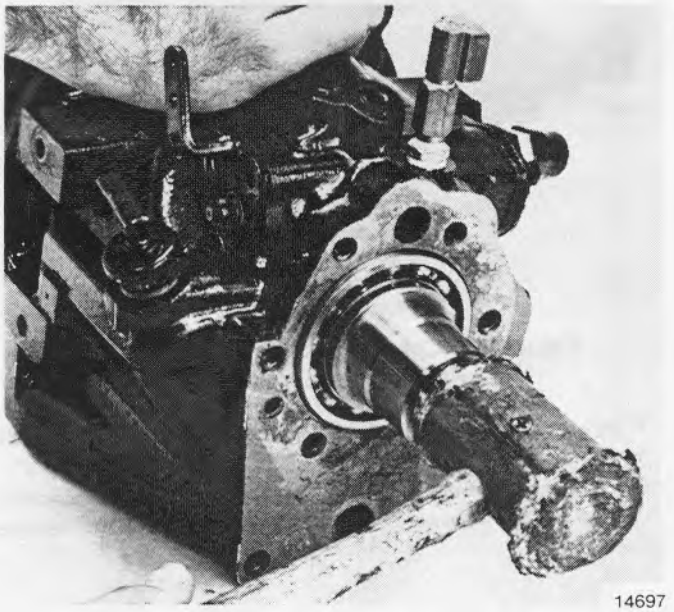
14693

a - Coupling
b - Expansion Plug
c - Ball Bearing
d - Snap Ring

Figure 2. Coupling Assembly

7. Pressing on inner race only, press ball bearing onto coupling (with numbered side up) until it bottoms out. Install snap ring.

IMPORTANT: Some bearings may have a groove completely around the outer race. Install this type bearing with the groove away from transmission.



14697

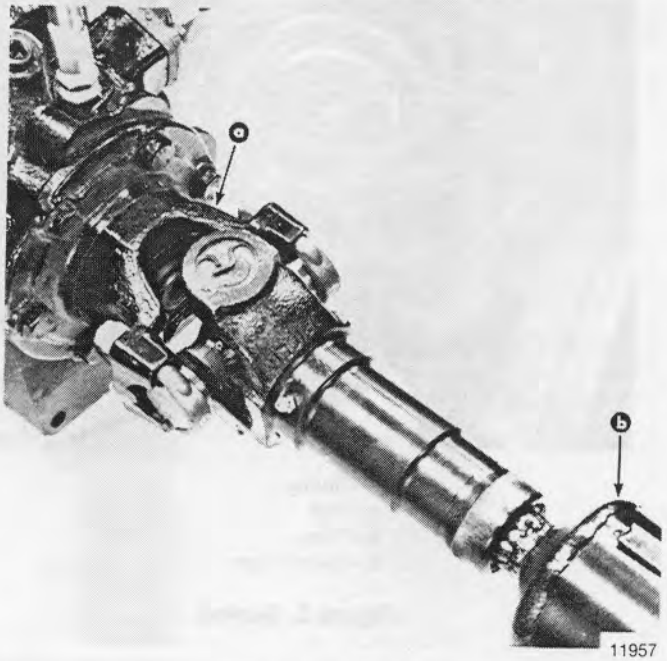
Figure 3. Installing Coupling Assembly

8. Install coupling assembly on output shaft splines and tap into place using a soft tip mallet. (Figure 3)

STERN DRIVE TRANSMISSION (FORWARD MOUNTED ENGINE) YOKE REPLACEMENT

⚠CAUTION

Drive shaft has been assembled and balanced at the factory with the universal joint yokes (on both ends of shaft) running in the same plane. Refer to "Section 2, Part H" BEFORE proceeding.



a - Transmission Yoke
b - Drive Shaft

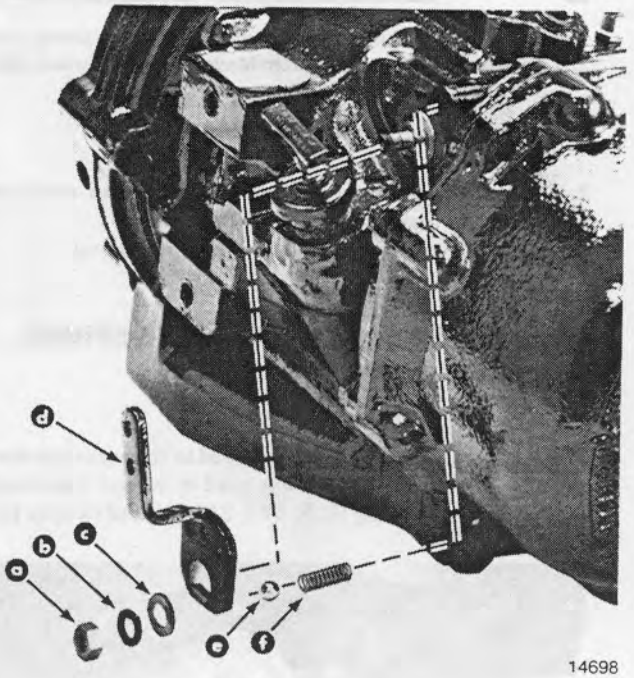
Figure 4. Forward Mounted Engine

1. Disconnect drive shaft from transmission yoke, as outlined.
2. Drain transmission.
3. Hold yoke and remove nut.
4. Using a puller, remove yoke from transmission output shaft.
5. Inspect transmission seal.
6. After lubricating lip of seal, align splines in yoke with splines on output shaft.
7. Gently press yoke onto shaft, until contact with inner race of bearing (in transmission) is made.
8. Install nut and torque to specifciations.
9. Reconnect drive shaft as outlined in "Section 7, Part H".
10. Refill transmission.
11. Check for leaks and fluid level after first start up of engine.

SHIFT LEVER INSTALLATION

IMPORTANT: Warner Gear warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed in any manner, or repositioned, or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

Shift lever and related parts must be assembled as shown in Figure 4. Lubricate poppet ball, spring and holes in shift lver with 2-4-C Multi-Lube prior to assembly. Torque shift lever attaching nut to specifications. After installation, move shift lever thru forward, neutral and reverse positions. No more than finger tip effort should be required. If valve binds, cause for binding MUST BE found and corrected.

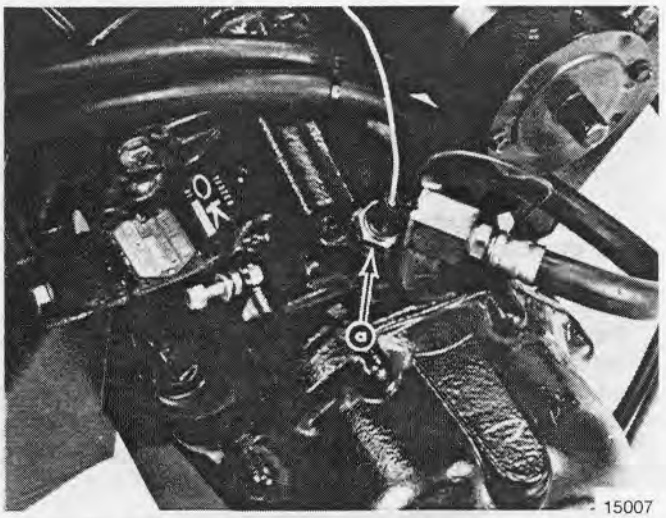


a - Nut
b - Lockwasher
c - Flat Washer
d - Shift Lever
e - Poppet Ball
f - Poppet Spring

Figure 5. Shift Lever Installation

PRESSURE TEST

1. Install pressure gauge at location shown in Figure 1.



a - Main Line Pressure Tap - Models with Audio Warning System: Remove Temperature Switch: Models without Switch: Remove 3/8" Pipe Plug.

Figure 1. Pressure Tap

2. With boat in water, start engine and run until normal operating temperature is reached.
3. Refer to "Specifications for pressure readings.

PRESSURE REGULATOR VALVE SPRING IDENTIFICATION

Two different springs have been used in the transmission. The black spring (P.N. 71-242) was used in earlier transmissions, while the white spring (P.N. 72N-242) is used in later production transmissions. Refer to "Identification" for starting serial numbers of transmissions that use the white spring. Visual inspection can be used to determine color of spring.

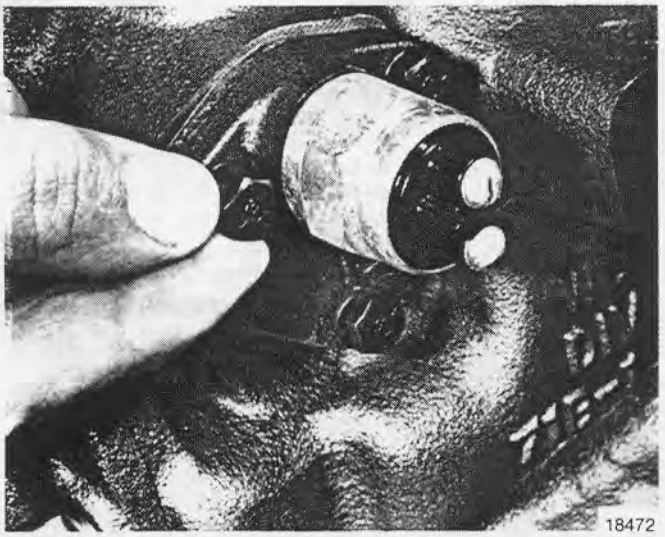
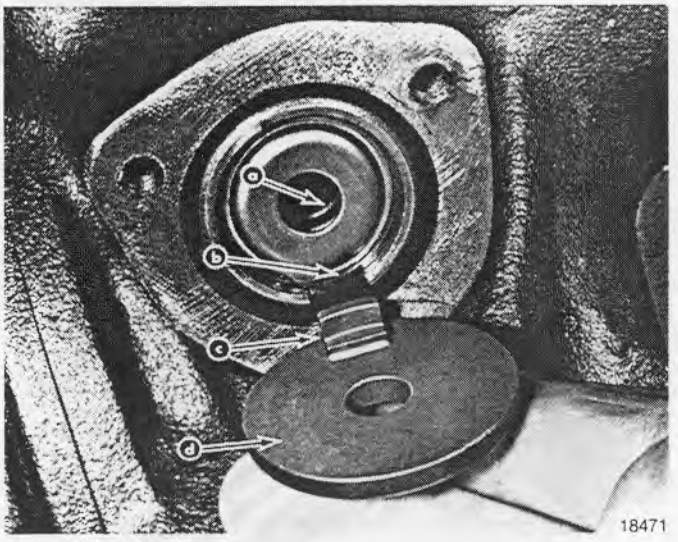


Figure 2. Neutral Start Safety Switch

1. Remove neutral start safety switch. (Figure 2)
2. Remove switch cam, then look thru hole (with flashlight) to determine color of spring. (Figure 3)



a - Spring
b - Slot
c - Tang
d - Switch Cam

Figure 3. Spring

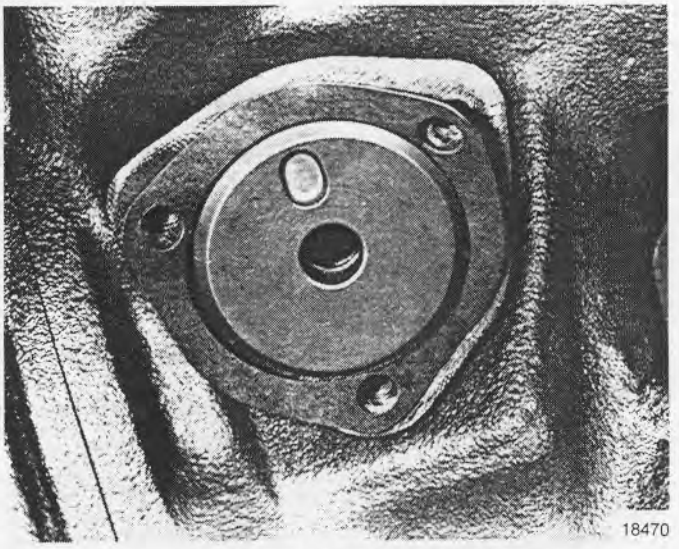
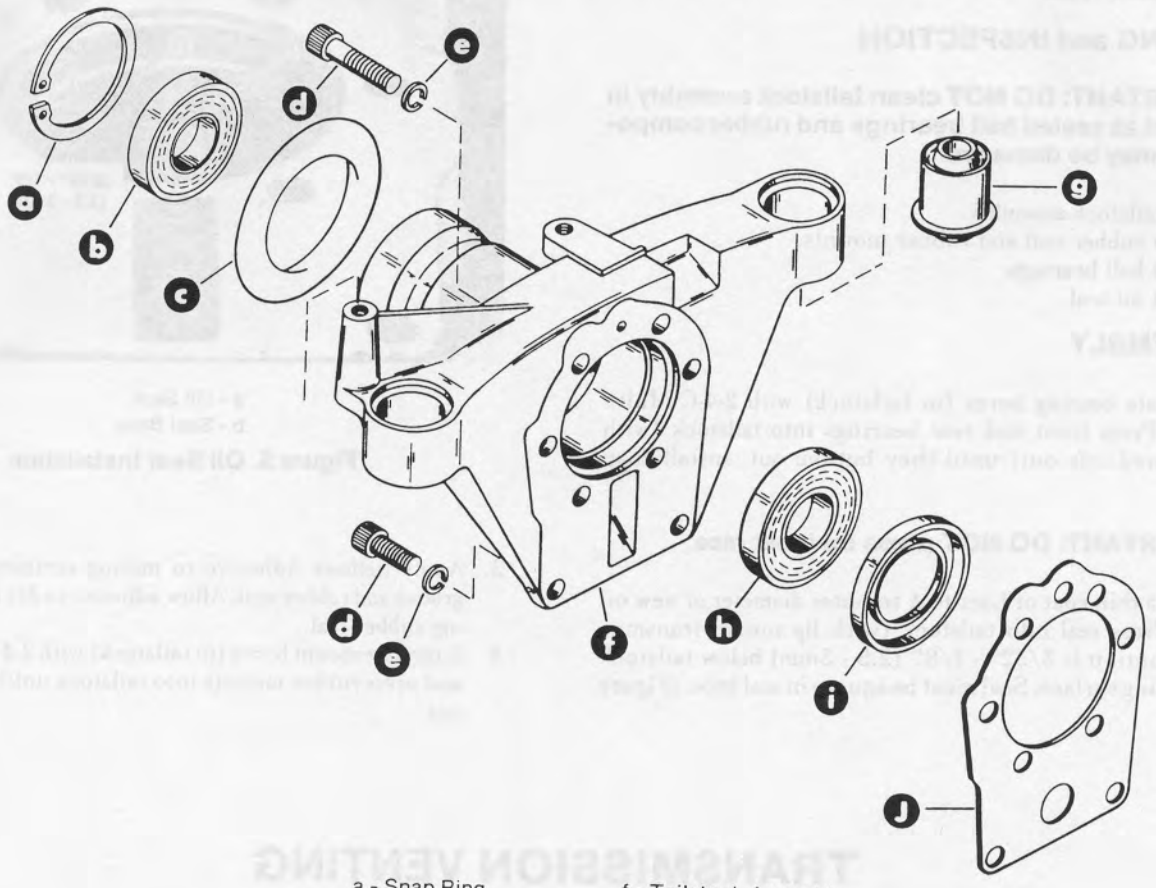


Figure 4. Correct Switch Cam Position

3. Reinstall switch cam. Make sure tang is in slot. (Figure 3).
4. Before installing neutral start safety switch, be sure switch cam is positioned as shown in Figure 4, then install switch. Torque bolts to specifications.

TAILSTOCK ASSEMBLY REPAIR



a - Snap Ring
b - Ball Bearing
c - Seal
d - Screw (8)
e - Lockwasher (8)
f - Tailstock Assembly
g - Rubber Mount (2)
h - Ball Bearing
i - Oil Seal
j - Gasket

Figure 1. Tailstock Assembly

REMOVAL/INSTALLATION

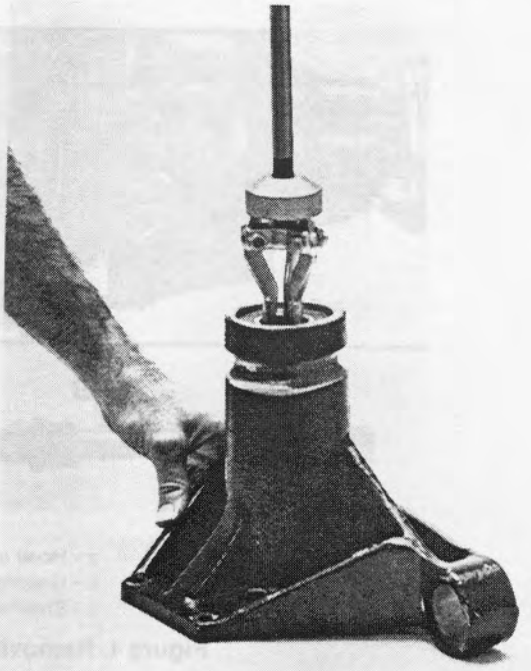
1. Remove tailstock to transmission attaching screws and remove tailstock. Discard gasket.
2. After repairs, apply Loctite A to threads of tailstock attaching screws. Apply RTV Sealer to both sides of new gasket.
3. Install gasket and tailstock on transmission with screws. Hex head screws are installed in 2 lower mounting holes.
4. Torque screws to specifications.

DISASSEMBLY

1. Remove rubber seal from aft end of tailstock.

IMPORTANT: Bearings, oil seal and rubber mounts must be replaced, if removed.

2. Press rubber mounts out of tailstock.
3. Remove snap ring then, remove bearing using Slide Hammer Puller. (Figure 2)
4. Remove oil seal.
5. Using Slide Hammer Puller, remove front bearing.



14695

Figure 2. Removing Rear Ball Bearing

IMPORTANT: DO NOT pry seal out with a screwdriver as tailstock surface may be damaged, causing a fluid leak.

CLEANING and INSPECTION

IMPORTANT: DO NOT clean tailstock assembly in solvent as sealed ball bearings and rubber components may be damaged.

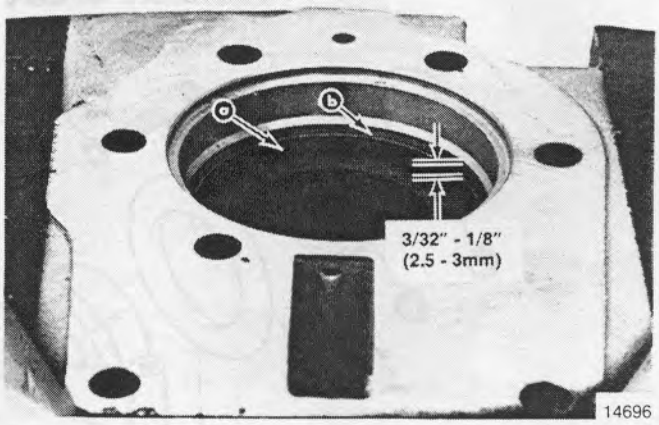
1. Clean tailstock assembly.
2. Inspect rubber seal and rubber mounts.
3. Inspect ball bearings.
4. Inspect oil seal.

REASSEMBLY

1. Lubricate bearing bores (in tailstock) with 2-4-C Multi-Lube. Press front and rear bearings into tailstock (with numbered side out) until they bottom out. Install snap ring.

IMPORTANT: DO NOT press on inner race.

2. Apply a thin coat of Loctite A to outer diameter of new oil seal. Press seal into tailstock (with lip toward transmission) until it is 3/32" - 1/8" (2.5 - 3mm) below tailstock mounting surface. Seal must be square in seal bore. (Figure 3)



a - Oil Seal
b - Seal Bore

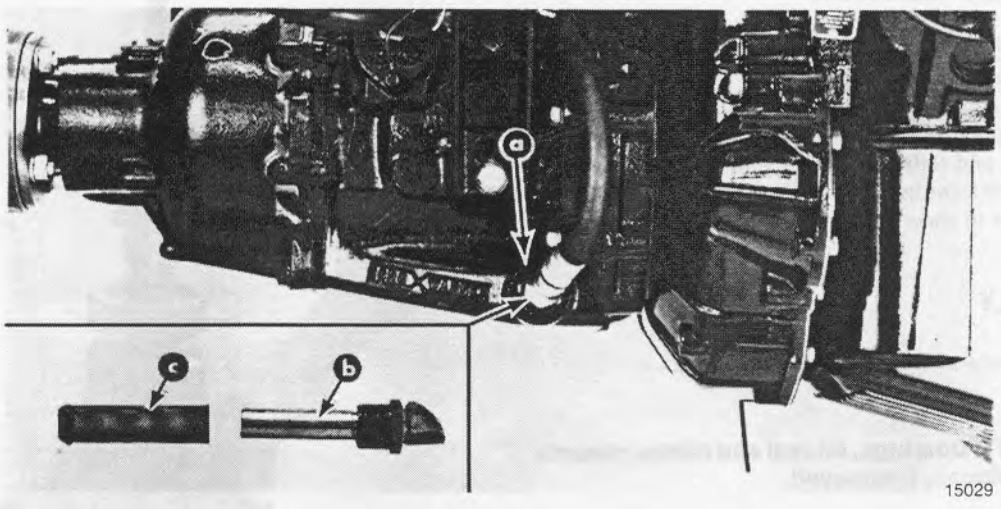
Figure 3. Oil Seal Installation

3. Apply Bellows Adhesive to mating surfaces of tailstock groove and rubber seal. Allow adhesive to dry before installing rubber seal.
4. Lubricate mount bores (in tailstock) with 2-4-C Multi-Lube and press rubber mounts into tailstock until they bottom-out.

TRANSMISSION VENTING

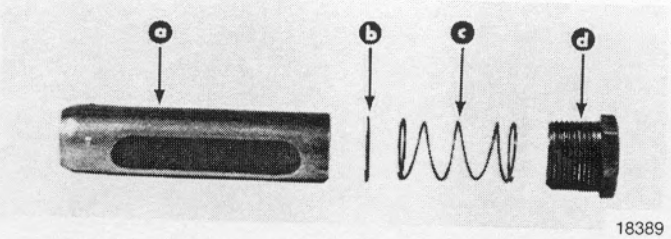
Under certain operating conditions such as, but not limited to; constant high RPM operation or high engine angle (while underway), can cause the transmission to vent fluid out of the vent tube. To help correct this condition, determine the model and gear ratio of the transmission that is having the venting problem.

1. Remove hose, then bushing from transmission. (Figure 1)
2. Remove charge tube and strainer and discard. (Figure 1)



a - Hose and Bushing
b - Unscrew Charge Tube ┐
c - Strainer ──────────┘ Discard

Figure 1. Removing Charge Tube and Strainer



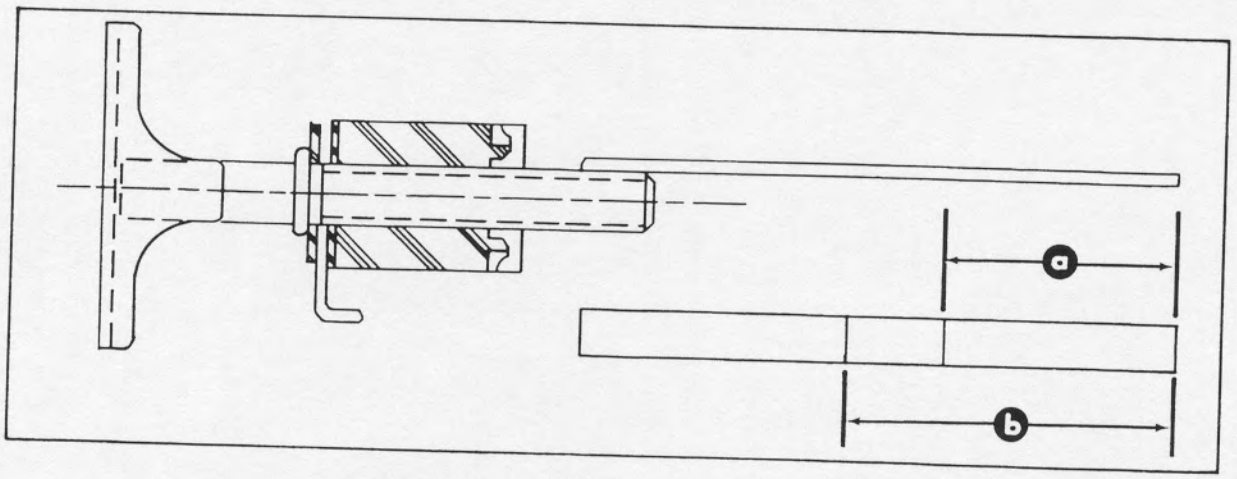
a - 72C-98 Oil Shield - Slot Toward Bottom of Transmission
b - 35-143 Washer
c - 5L-222 Spring
d - Bushing

Figure 2. Installing Oil Shield

3. Install oil shield, washer and spring. (Figure 2)

IMPORTANT: Oil shield, washer and spring are Warner Gear Parts. Order form their dealers.

4. Coat threads of bushing with Perfect Seal and install into transmission. Torque to specifications.
5. Reconnect hose and tighten fitting securely.
6. Lower fluid level in transmission by remarking dipstick as shown in Figure 3.
7. Refill transmission as outlined under "Changing Fluid".

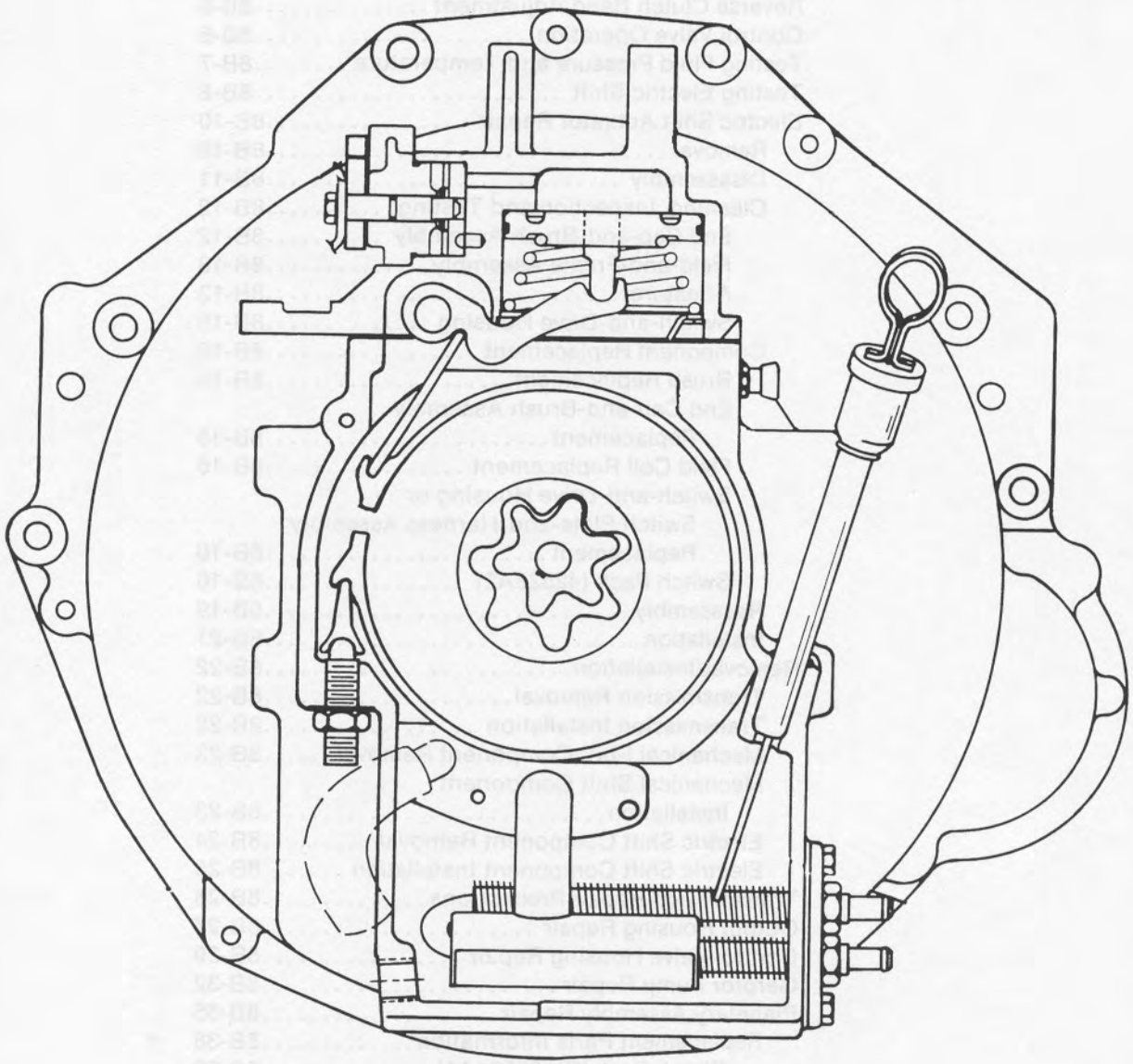


a - 10-17 (1:1 Only) - 1-1/8" (29mm) New Full Mark
10-17 (1.5:1 - 3.0:1 Only)
10-18 (All Ratios) — 1-1/4" (32mm) New Full Mark
b - Old Full Mark - 1-3/4" (44mm) From End

Figure 3. Remark Dipstick

SECTION 8 - DRIVE SYSTEM

PART B - MERCURY MARINE TRANSMISSION



MERCURY MARINE
A BRUNSWICK COMPANY

mercruiser
STERN DRIVES & INBOARDS

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TORQUE SPECIFICATIONS

ELECTRIC SHIFT ACTUATOR	
Fastener Location	**Lbs. In. (N.m)**
Actuator to Bracket	90 (10)
Armature End Play Screw	Bottom Out then Back-Off 1/8 - 1/4 Turn
Bracket to Control Valve	130 (15)
Pole Shoe to Field Frame	50 (6)
Reverse Lock Valve	75 (8)
Shift Actuator Crank Arm	60 (7)
Shift Link (Arm) to Control Valve Shaft	75 (8)
Shift Motor Thru-Bolts	25 (3)

MECHANICAL SHIFT ACTUATOR	
Fastener Location	**Lbs. In. (N.m)**
Bracket to Control Valve	130 (15)
Reverse Lock Valve	75 (8)
Shift Crank	210 (24)
Shift Lever to Control Valve Shaft	75 (8)

(OVER)

TRANSMISSION		
Fastener Fastener	**Lbs. Ft. (N.m)**	**Lbs. In. (N.m)**
Control Valve Cap		75 (8)
Control Valve Housing	18 (24)	
Gerotor Pump Cover		90 (10)
Gerotor Pump Housing		130 (15)
Gerotor Pump Housing Discharge Passage Plug	25 (34)	
Gerotor Pump Housing Pipe Plugs	17 (23)	
Gerotor Pump Relief Valve Plug	25 (34)	
Oil Cooler to Cover		125 (14)
Oil Cooler to Transmission		90 (10)
Oil Pickup		90 (10)
Output Housing	19 (26)	
Output Shaft Pipe Plug		90 (10)
Reverse Clutch Band Adjustment		(Note 1)
Transmission to Engine	30 (40)	
Transmission Housing Cover		80 (9)

NOTE 1: 120 Lbs. In. (14 N.m) then back-off 1-3/4 turn.

TOOLS/LUBRICANTS/SEALANTS

TOOLS	
91-65301 Δ	"T" Handles
91-65305 Δ	Piston Housing Compressor
91-65307 Δ	Planetary Holding Fixture
91-65304 Δ	Taper Plug
91-65302 Δ	Seal Ring Compressor Tool
91-68762 Δ	Seal Installing Tool
91-65303 Δ	Seal Ring Installing Tool
91-34569A1	Slide Hammer Puller

Δ Tools are included in 91-65307A1 Transmission Tool Kit. They can not be ordered separately.

LUBRICANTS/SEALANTS	
92-86154A1	Quicksilver 2-4-C Multi-Lube
92-25711	Quicksilver Liquid Neoprene
92-32609--1	Quicksilver Loctite "A"
Obtain Locally	Loctite 242 Blue
Obtain Locally	Loctite Primer "N"

SPECIFICATIONS

TRANSMISSION FLUID RECOMMENDATION

Dexron® II, Type F, and any other automatic transmission fluids (ATF) currently used in passenger cars are suitable for use in transmission.

Fluid Capacity (Approximately)		2 Qts. (1.9 litres)
Maximum Fluid Temperature		200° F (93° C) Max.
Fluid Pressure	750 RPM	80-105 psi
	4000 RPM	120-150 psi
Clutch Pack Clearance		.020" - .050" (.5 - 1mm)
Reverse Band Adjustment		(Note 1)

NOTE 1: 120 Lbs. In. (14mm) then back-off 1-3/4 turn.

SHIFT CABLE ADJUSTMENT (MECHANICAL SHIFT)

NOTICE
For shift cable adjustment, refer to "Section 2, Part F".

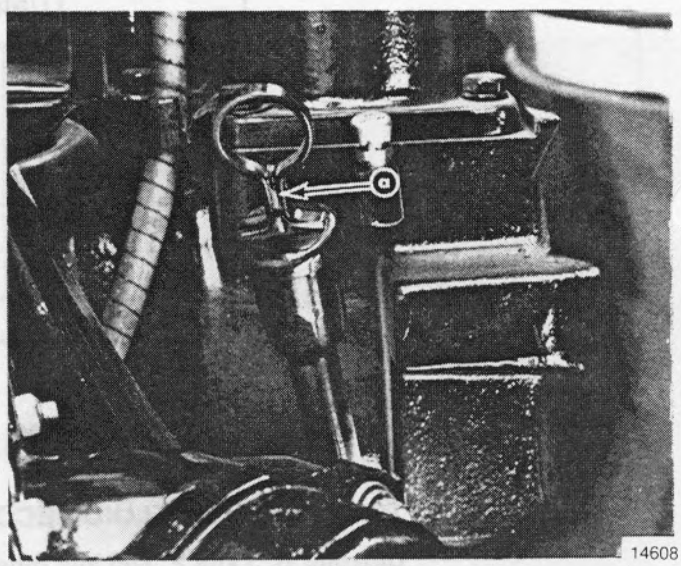
ATTACHING ELECTRIC SHIFT CONTROL (ELECTRIC SHIFT)

NOTICE
For electric shift control (remote control) wiring harness connections, refer to "Section 2, Part F".

CHECKING FLUID LEVEL

IMPORTANT: Use only fluid recommended in "specifications"

Transmission fluid level should be checked before starting engine each day. Check level with dipstick, located on starboard (right) side of transmission. (Figure 1) Fluid level should be maintained between "Full" and "Add" marks on dipstick. If low, add recommeded fluid thru dipstick tube to bring level up "Full" mark.



a - Dipstick

Figure 1. Transmission Dipstick Location

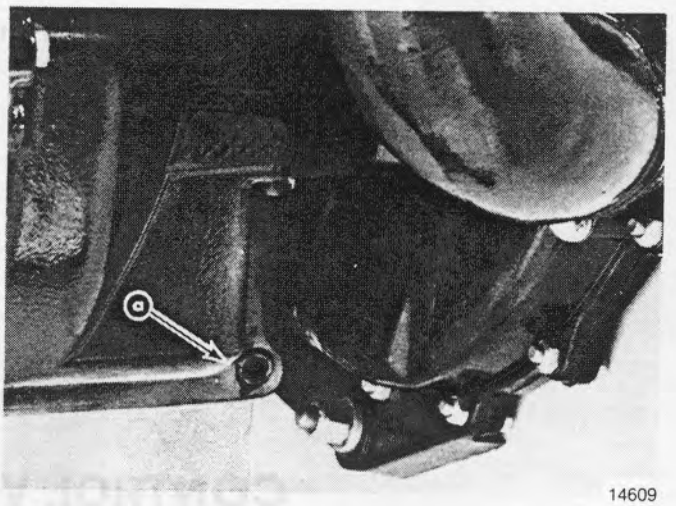
CHANGING FLUID

IMPORTANT: Use only fluid recommended in "Specifications".

1. Place a suitable container under drain location and remove drain plug. (Figure 1)
2. After transmission has drained completely, reinstall drain plug and tighten securely.
3. Fill transmission (thru dipstick tube) until level reaches "Full" mark on dipstick.

IMPORTANT: Fluid capacity is appoximately 2 quarts (1.9 litres).

4. Run engine for 2 minutes at idle to fill all circuits.
5. Stop engine and check fluid level on dipstick. Add fluid, as required, to bring level up to "Full" mark on dipstick.

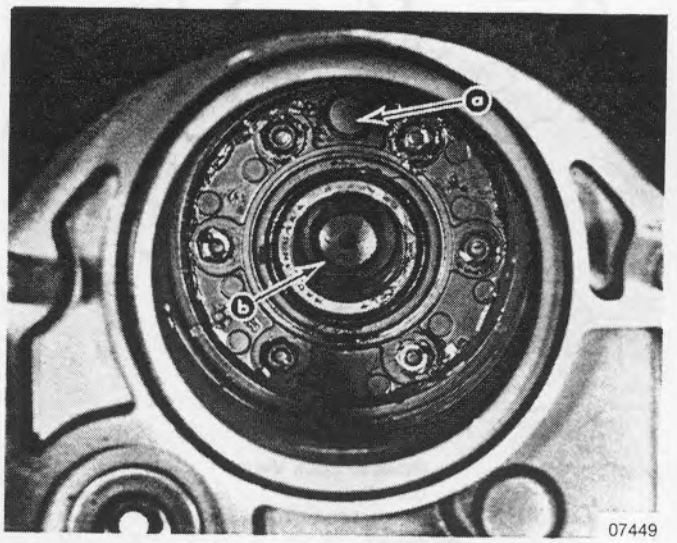


a - Drain Plug - Port (Left) Side

Figure 1. Drain Plug Location

LUBRICATION

1. Remove drive unit (refer to "Stern Drive Service Manual").
2. Remove cap from grease fitting (Figure 1) and lubricate output bearing with 2-4-C Multi-Lube until lubricant appears around bearing seal. Reinstall grease fitting cap.
3. Lubricate output shaft splines (Figure 1) and drive unit universal joint shaft splines with 2-4-C Multi-Lube.
4. Reinstall drive unit, using a new gasket.



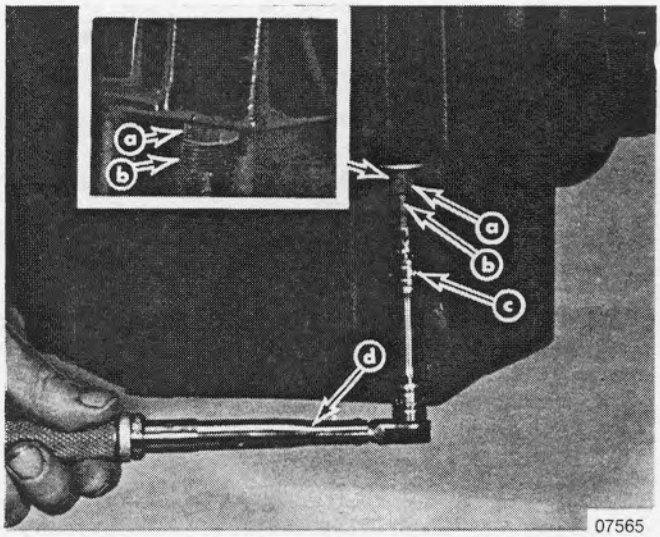
a - Grease Fitting and Cap
b - Output Shaft

Figure 1. Output Bearing and Shaft

REVERSE CLUTCH BAND ADJUSTMENT

Loosen jam nut (if not already done) and torque reverse clutch band adjusting screw to 120 lbs. in. (14 N.m) then back-off screw 1¾ turns and tighten locknut securely (be sure screw does not turn). (Figure 1)

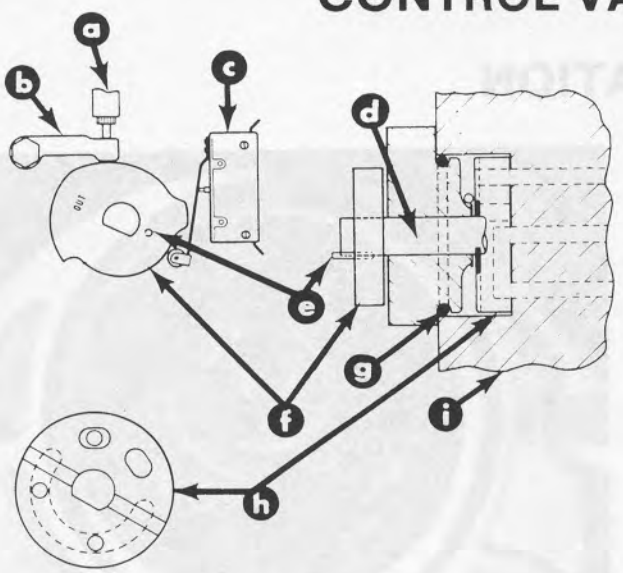
IMPORTANT: Readjust reverse clutch band after transmission has been shifted from forward to reverse and back several times.



a - Jam Nut
b - Reverse Band Adjusting Screw
c - Socket-Type Allen Wrench
d - Lb. In. Torque Wrench

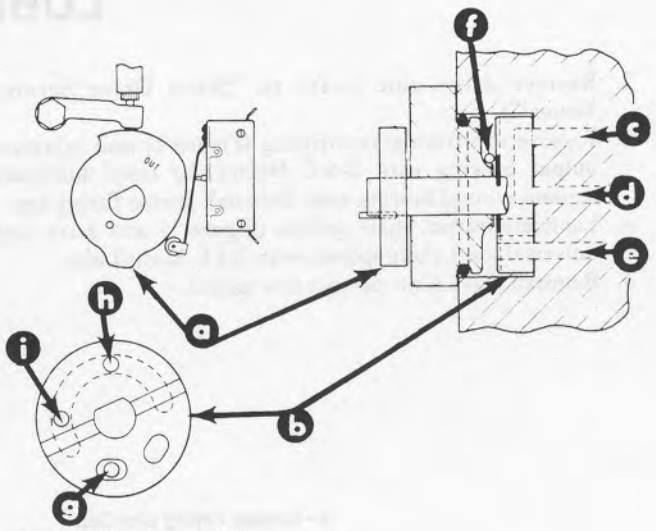
Figure 1. Adjusting Reverse Band

CONTROL VALVE OPERATION



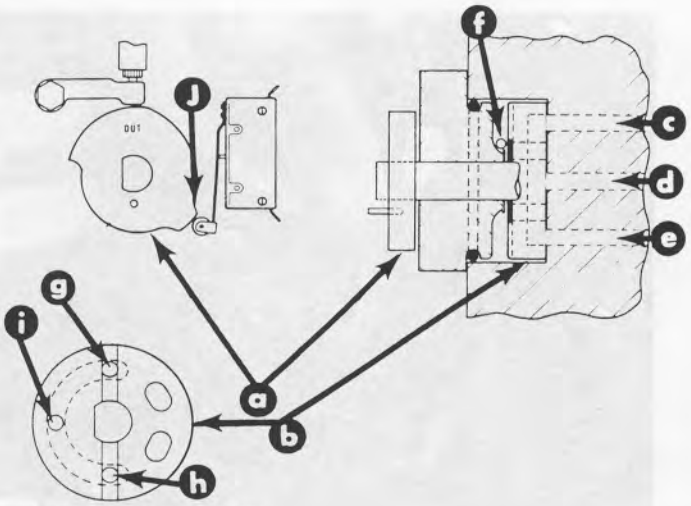
a - Reverse Lock Valve
b - Cam Follower
c - Neutral Start Safety Switch
d - Shaft
e - Roll Pin
f - Cam
g - "O" Ring
h - Control Valve Disc
i - Housing

Figure 1. Component Identification



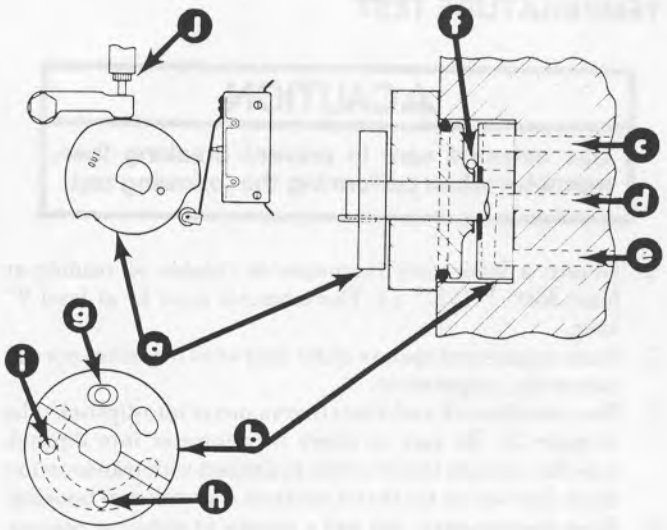
a - Note Position of Cam
b - Note Position of Disc
c - Reverse Port
d - Relief Port
e - Forward Port
f - Fluid Pressure (From Pump) - Into Control Valve
g - Fluid Pressure - Thru Disc to Forward Port, then to Forward Piston
h - Any Fluid Under Pressure from Reverse Port - Into Disc Groove
i - Fluid in Disc Groove - To Relief Port, then to Sump

Figure 2. Forward Gear Operation



a - Note Position of Cam
b - Note Position of Disc
c - Reverse Port
d - Relief Port
e - Forward Port
f - Fluid Pressure (From Pump) - Fills Area but Can Not Go Anywhere. Pressure Relief Valve (In Pump) opens Allowing Fluid to Return to Sump
g - Any Fluid Under Pressure from Reverse Port - Into Disc Groove
h - From Forward Port - Into Disc Groove
i - Fluid in Disc Groove - To Relief Port, then to Sump
j - Neutral Start Safety Switch Arm - On High Port of Cam Allowing Starter Motor to Crank.

Figure 3. Neutral Gear Operation



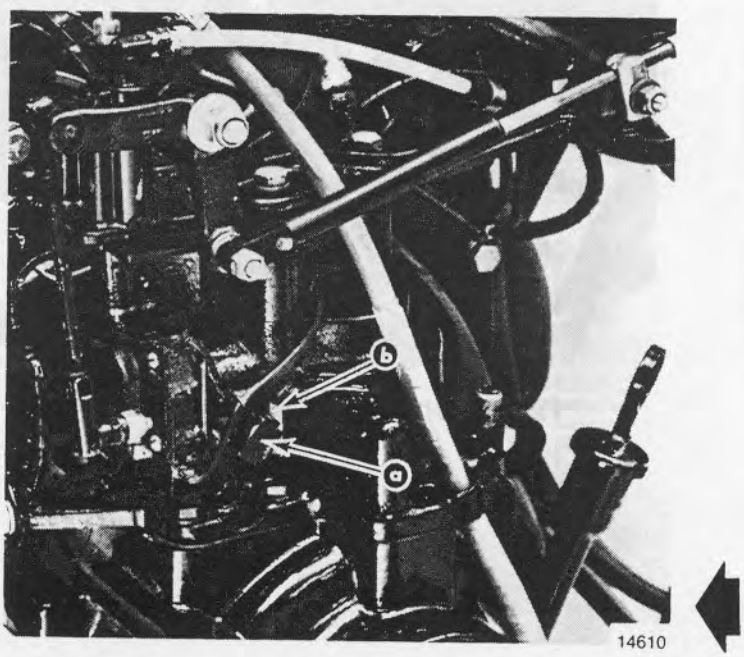
a - Note Position of Cam
b - Note Position of Disc
c - Reverse Port
d - Relief Port
e - Forward Port
f - Fluid Pressure (From Pump) - Into Control Valve
g - Fluid Pressure - Thru Disc to Reverse Port, then to Servo Piston
h - Any Fluid Under Pressure from Forward Port - Into Disc Groove
i - Fluid in Disc Groove - To Relief Port, then to Sump
j - Reverse Lock Valve Plunger - Down to Lock Drive Unit Down

Figure 4. Reverse Gear Operation

TESTING FLUID PRESSURE and TEMPERATURE

PRESSURE TEST

1. With engine stopped, remove pipe plug from elbow fitting on aft end of transmission (Figure 1) and connect a suitable oil pressure gauge to elbow fitting.



a - Elbow Fitting b - Pipe Plug

Figure 1. Transmission Elbow Fitting Location

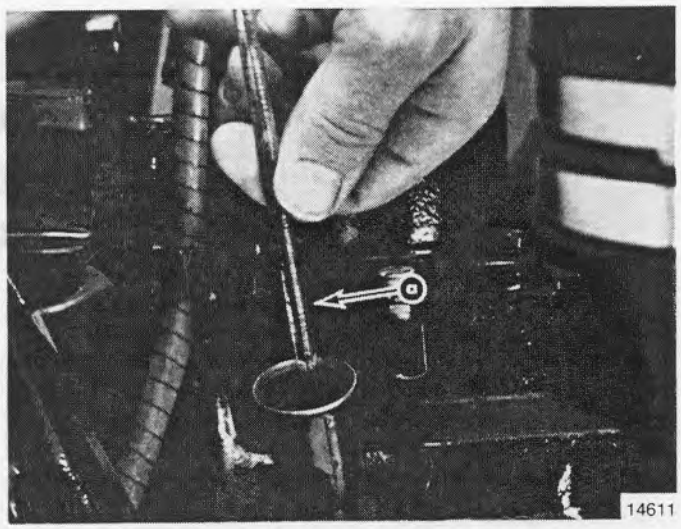
2. Start engine and run until it reaches normal operating temperature. Adjust engine RPM to 750 in neutral gear and observe gauge. Normal pressure should be 80-105 psi (552-724 kPa).
3. Shift transmission into forward, neutral and reverse and note pressure at each position (after it has stabilized). Pressure should not fluctuate more than 5 psi. (34 kPa).
4. Water test boat and engine at 4000 RPM (in forward gear) and observe gauge. Normal oil pressure should be 120-150 psi (827-1034 kPa).
5. If oil pressure is not within prescribed range in any of the tests, refer to appropriate troubleshooting chart.

TEMPERATURE TEST

⚠CAUTION

Use extreme care to prevent breaking thermometer when performing the following test.

1. Obtain a laboratory thermometer capable of reading at least 350° F (177° C). Thermometer must be at least 9" long.
2. Start engine and operate under load until it reaches normal operating temperature.
3. Remove dipstick and insert thermometer into dipstick tube (Figure 2). Be sure to insert thermometer into dipsitck tube far enough that it comes in contact with transmission fluid, but not so far that it contacts transmission housing.
4. After thermometer has had a chance to stabilize, remove thermometer and observe reading. Temperature should not exceed 200° F (93° C). If temperature is excessive, refer to appropriate troubleshooting chart.



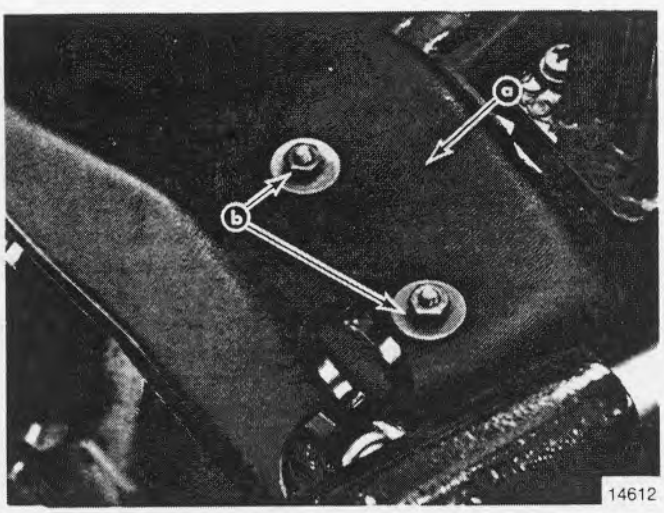
a - Thermometer

Figure 2. Testing Transmission Temperature

TESTING ELECTRIC SHIFT

If electric shift motor does not work, perform the following tests to determine if the malfunction is in the remote control shift switch, harness or electric shift actuartor.

1. Make sure that ignition switch is in the "Off" position.
2. Remove nuts, lockwashers and flat washers which secure shift motor cover and remove cover. (Figure 1)



a - Shift Motor Cover b - Nuts, Lockwashers and Flat Washers

Figure 1. Shift Motor Cover

IMPORTANT: Use extreme care when performing the following steps to prevent remote control shift harness leads from contacting the surrounding shift actuator parts and grounding out.

3. Disconnect remote control shift harness leads from terminal block (Figure 2) and position so they will not touch each other or surrounding parts.

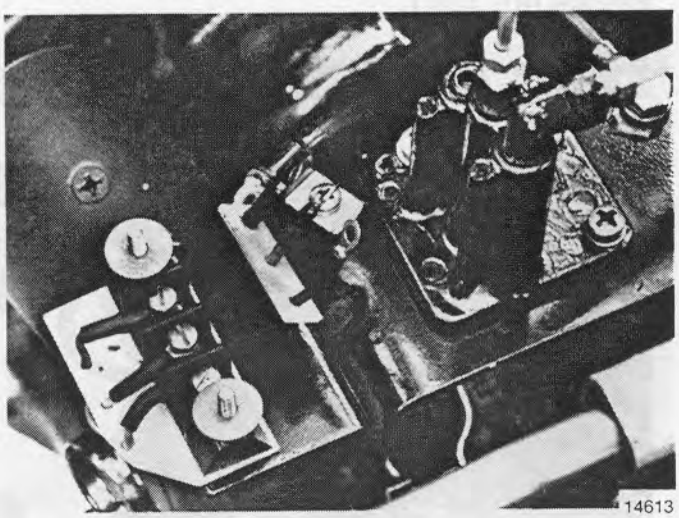
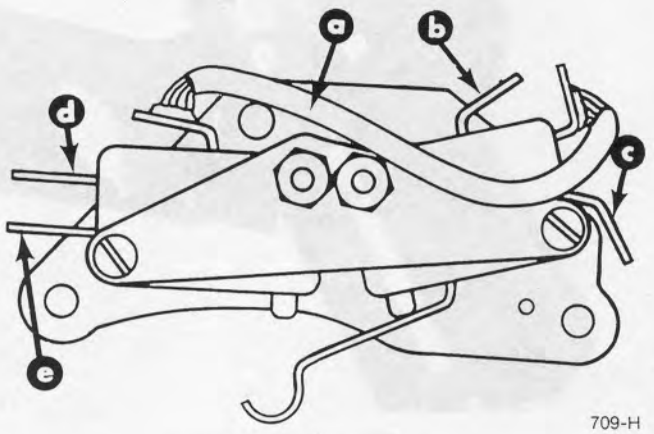


Figure 2. Harness Leads Disconnected

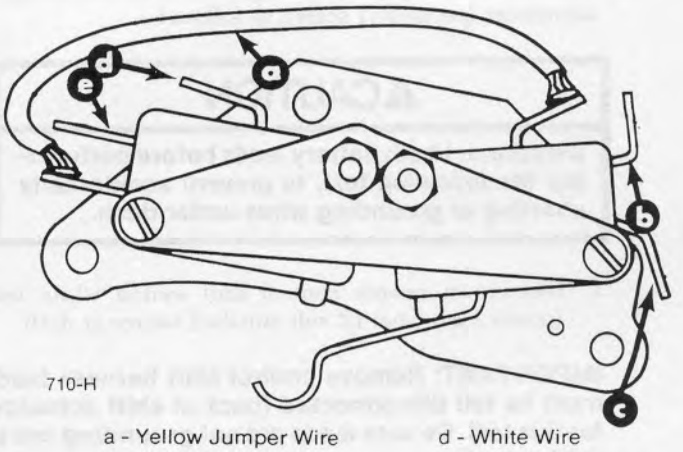
4. Test remote control shift switch and harness for short or open circuits, using a D.C. voltmeter (set on 0-20 volt scale), as follows:
   a. Connect positive (+) voltmeter lead to blue remote control shift harnes lead and negative (-) voltmeter lead to a ground. (Figure 2)
   b. Turn ignition switch to "Run" position.
   c. Observe voltmeter readings while shifting remove control into forward, neutral and reverse several times.
   d. Repeat procedure with positive (+) voltmeter lead connected to orange shift lead then green shift lead.
   e. The following readings should be observed.
      Blue Lead -
         Forward - 0 Volts
         Neutral - 0 volts
         Reverse - Battery Voltage (Approx. 12 Volts)
      Orange Lead -
         Forward - 0 Volts
         Neutral - Battery Voltage
         Reverse - 0 Volts
      Green Lead -
         Forward - Battery Voltage
         Neutral - 0 Volts
         Reverse - 0 Volts
   f. If readings are correct, proceed to Step 5.
   g. If any of the readings are incorrect but battery voltage is indicated on at least one of the leads, switch or harness is bad. To determine which is at fault disassemble remote control and disconnect harness from switch. Test harness for open or short circuits, using an ohmmeter (set on Rx1 scale). If harness checks out good, switch is bad and must be replaced. Refer to Figures 3, 4 or 5 for wire connections.
   h. If battery voltage is not indicted on any of the leads, check shift switch white lead (power lead) for loose or dirty connections. If a poor connection is not the problem switch is bad and must be replaced.



709-H

a - Yellow Jumper Wire
b - White Wire
c - Green Wire
d - Blue Wire
e - Orange Wire

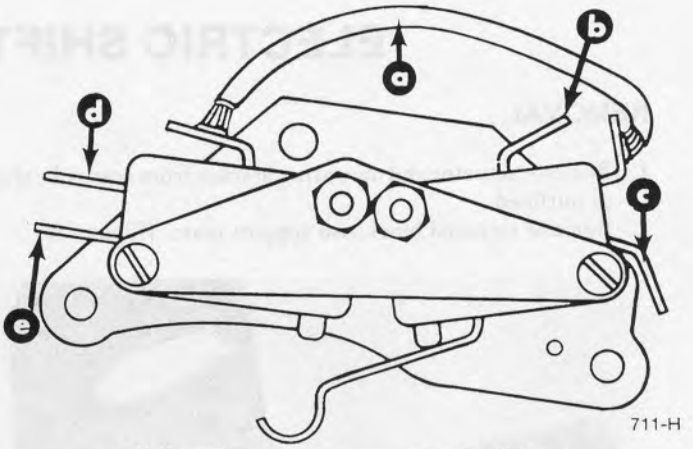
Figure 3. 62919A3 Switch Assembly



710-H

a - Yellow Jumper Wire
b - Orange Wire
c - Blue Wire
d - White Wire
e - Green Wire

Figure 4. 63979A5 Switch Assembly



711-H

a - Yellow Jumper Wire
b - White Wire
c - Green Wire
d - Blue Wire
e - Orange Wire

Figure 5. 63979A6 Switch Assembly

IMPORTANT: The following test need only be performed if troubleshooting the cause for excessive current draw, usually indicated by blowing ignition switch fuse (if so equipped) or tripping circuit breaker on engine.

5. Test switch and harness for a grounded circuit using an ohmmeter (set on Rx1 scale), as follows:

⚠CAUTION

Disconnect both battery leads before performing the following test, to prevent accidentally shorting or grounding wires under dash.

a. Disconnect remote control shift switch white lead (power lead) from 12 volt switched source at dash.

IMPORTANT: Remove control shift harness leads must be left disconnected (back at shift actuator) for this test. Be sure leads are not grounding out to shift actuator.

b. Connect one ohmmeter lead to white lead and the other ohmmeter lead to remote control housing.

c. Observe ohmmeter while shifting into forward, neutral and reverse several times.

d. Repeat test between white lead and dash ground terminal.

e. No continuity (meter movement) should be indicated in any position.

f. If continuity exists, disassemble remote control and remove shift switch and harness from remote control housing. Inspect harness insulation for chafing or other damage which would allow it to ground out to housing. If no damage can be found, repeat continuity test between shift switch white lead and dash ground terminal while actuating switch manually. Be sure switch does not touch remote control housing.

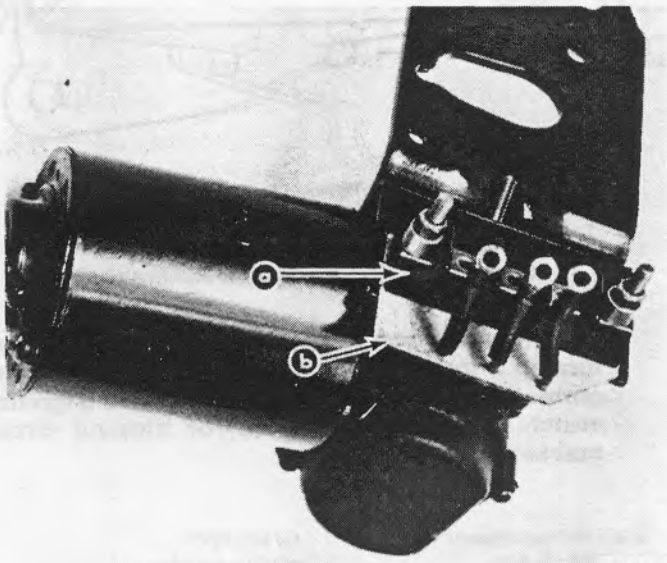
g. If continuity is now eliminating, shift switch is bad and must be replaced. If continuity is still indicated, harness is bad and must be repaired or replaced.

6. If shift switch and remote control shift harness test out good, remove electric shift actuator, disassemble and test as explained in "Electric Shift Actuator Repair".

ELECTRIC SHIFT ACTUATOR REPAIR

REMOVAL

1. Remove actuator and mounting bracket from control valve as outlined.
2. Remove terminal block and support plate. (Figure 1)



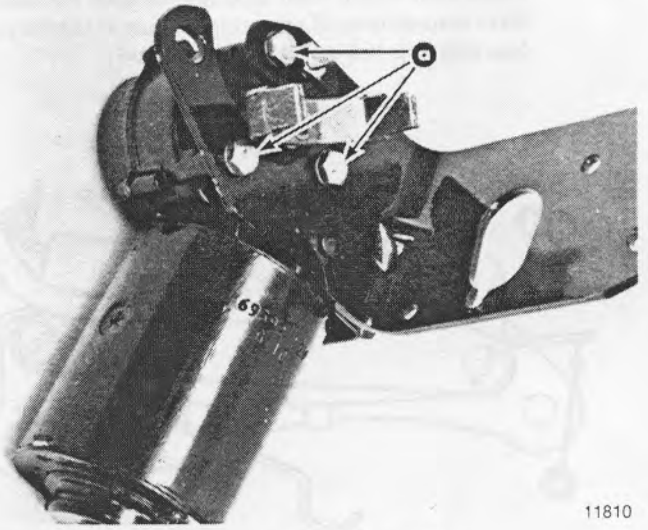
11811

a - Terminal Block
b - Support Plate

Figure 1. Shift Actuator

3. Remove actuator from mounting bracket. (Figure 2)

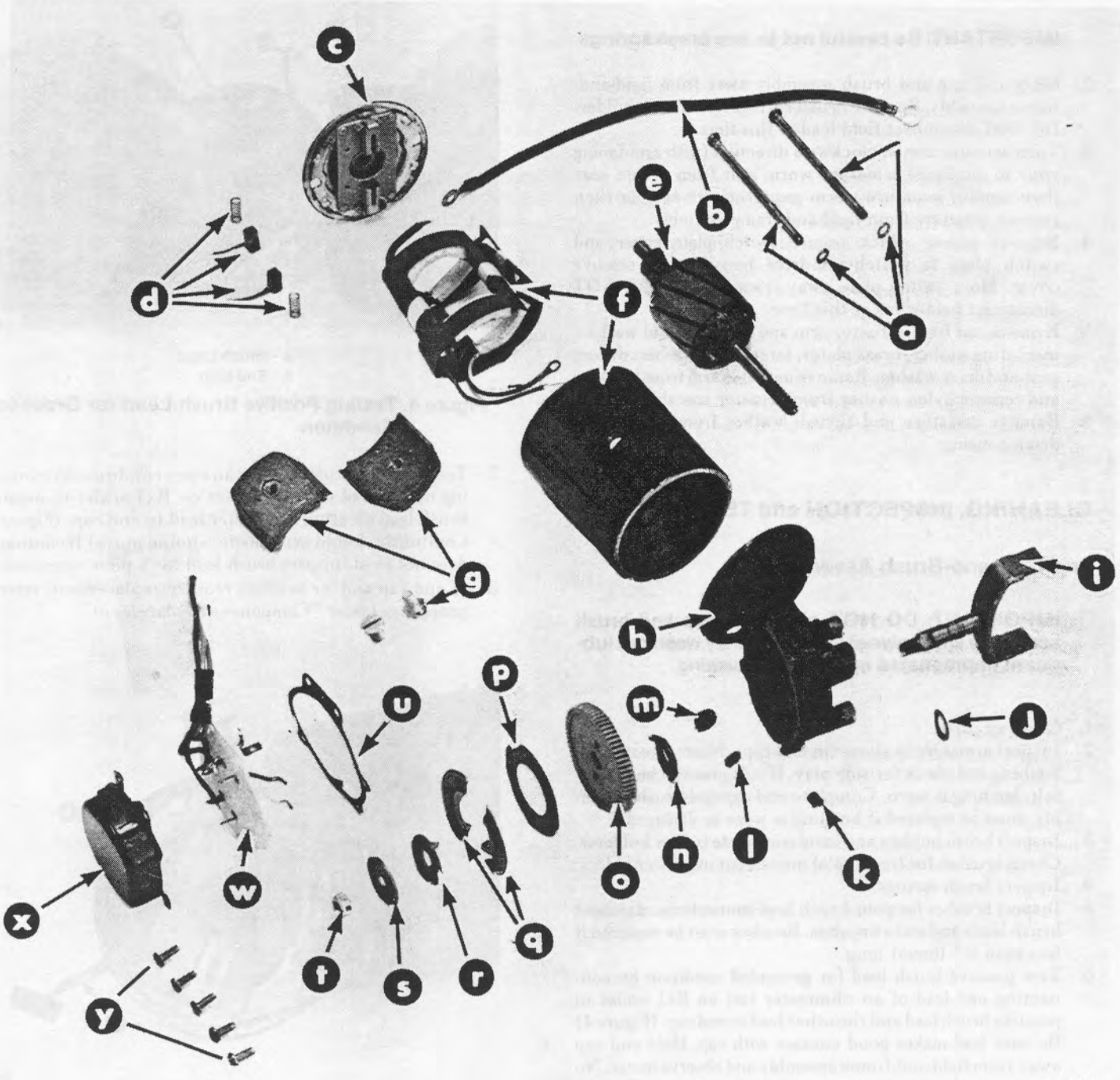
IMPORTANT: If actuator arm interferes with screw removal, connect motor black lead to negative (-) battery terminal. Connect motor blue or green lead to positive (+) battery terminal until arm moves enough to remove screw. If motor does not run, armature must be removed to move arm.



11810

a - Screws/Lockwashers (3)

Figure 2. Remove Bracket



a - Thru Bolts/Lockwashers (2)
b - Ground Wire
c - End Cap
d - Brushes/Springs (2)
e - Armature
f - Field and Frame
g - Pole Shoe and Screws (2)
h - Switch and Drive Housing
i - Actuator Arm
j - Small Nylon Washer
k - Screw, Armature End Play Adjusting
l - Washer, Armature End Thrust
m - Grommet
n - Drive Washer
o - Driven Gear
p - Large Nylon Washer
q - Brass Plates
r - Insulating Washer
s - Metal Washer
t - Nut
u - Gasket
v - Switch Plate and Harness Assembly
w - Cover
x - Screws

Figure 3. Actuator Parts View

1. Remove 2 thru bolts, lockwashers and ground wire from shift motor.

IMPORTANT: Be careful not to lose brush springs.

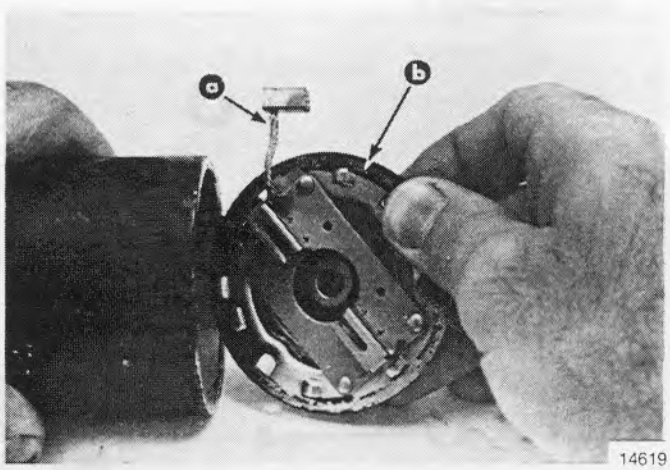
2. Move end cap and brush assembly away from field-and-frame assembly. Remove brush springs from brush holder. DO NOT disconnect field lead at this time.
3. Turn actuator arm in clockwise direction (with arm facing you) to disengage armature worm gear from driven gear then remove armature worm gear from driven gear then remove armature from field-and-frame assembly.
4. Remove screws which secure switch plate cover and switch plate to switch-and-drive housing and remove cover. Move switch plate away from housing. DO NOT disconnect field wires at this time.
5. Remove nut from actuator arm and remove metal washer, insulating washer, brass plates, large nylon washer, driven gear and drive washer. Remove actuator arm from housing and remove nylon washer from actuator arm shaft.
6. Remove armature end thrush washer from switch-and-drive housing.

CLEANING, INSPECTION and TESTING

End Cap-and-Brush Assembly

IMPORTANT: DO NOT clean end cap and brush assembly with solvent as solvent may wash out lubricant impregnated in armature bushing.

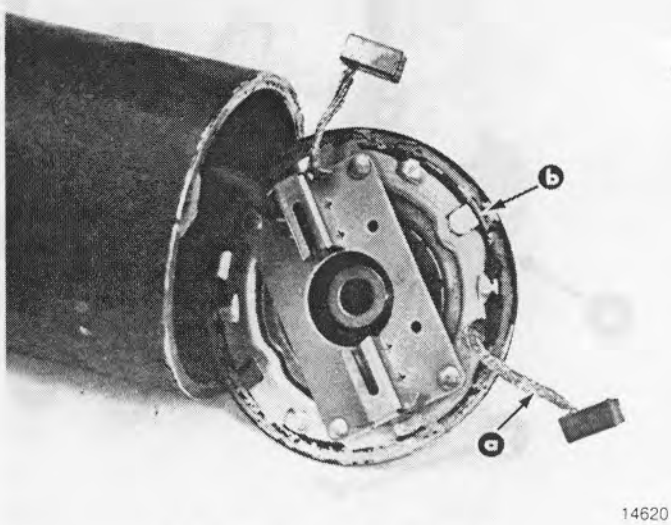
1. Clean all parts.
2. Inspect armature bushing (in end cap). Insert armature in bushing and check for side play. If side play can be readily felt, bushing is worn. Complete end cap-and-brush assembly must be replaced if bushing is worn or damaged.
3. Inspect brush holders and insulating plate (under holders). Check brushes for freedom of movement in brush holders.
4. Inspect brush springs.
5. Inspect brushes for poor brush lead connections, damaged brush leads and worn brushes. Brushes must be replaced if less than ¼" (6mm) long.
6. Test positive brush lead for grounded condition by connecting one lead of an ohmmeter (set on Rx1 scale) to positive brush lead and the other lead to end cap. (Figure 4) Be sure lead makes good contact with cap. Hold end cap away from field-and-frame assembly and observe meter. No continuity should exist (meter should not move). If continuity exists, positive brush lead is grounded. Inspect brush lead connection for excessive solder. If excess solder is not the cause, end cap-and-brush assembly must be replaced.



a - Brush Lead
b - End Cap

Figure 4. Testing Positive Brush Lead for Grounded Condition

7. Test negative brush lead for an open condition by connecting one lead of ohmmeter (set on Rx1 scale) to negative brush lead on other ohmmeter lead to end cap. (Figure 5) Continuity should exist (meter should move) If continuity does not exist, inspect brush lead for a poor conection.
8. If end cap and/or brushes require replacement, refer to procedure under "Component Replacement".



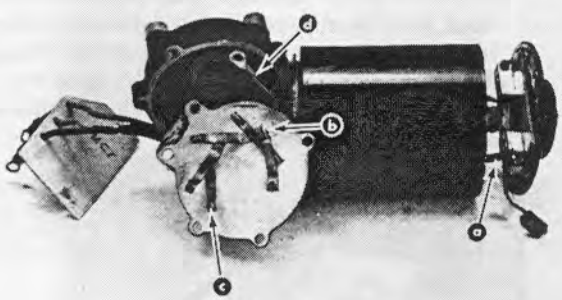
a - Brush Lead b - End Cap

Figure 5. Testing Negative Brush Lead for Open Condition

Field-and-Frame Assembly

IMPORTANT: DO NOT clean field-and-frame assembly with solvent as it may dissolve the insulation and short windings.

1. Blow out with compressed air and wipe clean with a cloth.
2. Inspect field winding and leads for visible damage.
3. Check pole shoe attaching screws for adequate tightness. If loose, inspect pole shoes and armature laminations for damage.
4. Test field windings for opens, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect one lead of meter to field to positive brush holder lead and other lead to contact on switch plate to which yellow field lead is attached. (Figure 6) Continuity should exist (meter should move). If continuity does not exist, field is open.
   b. Move ohmmeter lead from yellow field lead contact to green field lead contact on switch plate and check this winding for an open condition. (Figure 6)
   c. Move ohmmeter lead from green field lead contact to black field lead and check this winding for an open. (Figure 6)
   d. If any windings are open, field coil assembly must be replaced.



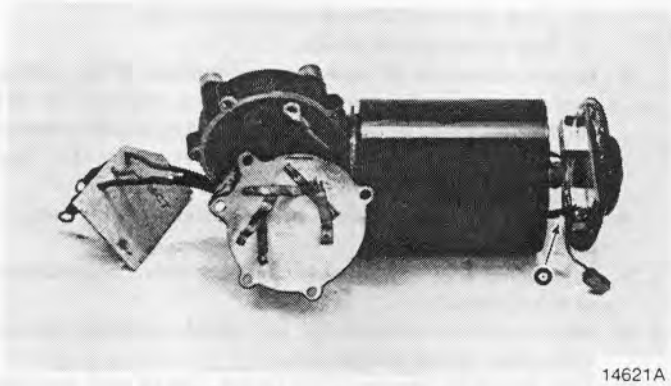
14621

a - Field to Positive Brush Holder Lead
b - Yellow Field Lead Switch Plate Contact
c - Green Field Lead Switch Plate Contact
d - Black Field Lead

Figure 6. Testing Field Windings for Open Condition

IMPORTANT: An open or short in field winding to which black field lead is attached may cause shift actuator to hunt when shifting.

5. Check field winding for grounded condition by connecting one lead of ohmmeter (set on Rx1 scale) to field to positive brush holder lead and other lead to field frame. (Figure 7) Be sure switch plate contacts and positive brush lead are not grounding out. No continuity should be indicated (meter should not move). If continuity exists, field windings are grounded. Inspect field leads for damaged insulation causing them to ground out to field frame. If ground cannot be found, field coil assembly must be replaced.



14621A

a - Field to Positive Brush Holder Lead

Figure 7. Testing Field Windings for Grounded Condition

6. A short in the field winding is difficult to detect without special laboratory equipment due to the low resistance of the windings. If all other electrical components test good, but motor fails to produce adequate power, field winding is probably shorted and field coil assembly must be replaced. Heat discoloration of windings is usually indicative of a short or a ground.
7. If field coil assembly requires replacement, refer to procedure under "Component Replacement".

Armature

IMPORTANT: DO NOT clean armature with solvent, as solvent may dissolve insulation and short windings.

1. Clean armature with compressed air and a cloth.

IMPORTANT:DO NOT USE emery cloth to clean commutator, in next step, as emery particles are conductive and may short out armature if they become embedded between commutator bars.

2. Inspect commutator for roughness, pitting, grooves, high mica, burned or dirty commutator bars, out-of-roundness or other abnormal wear. Burned commutator bars are usually an indication of an open circuited armature coil. Minor roughness or dirty commutator bars can be cleaned up with 00 grit sandpaper. After cleaning bars, carefully clean out slots between bars to remove any dirt and copper dust. If wear or damage cannot be removed with sandpaper or if commutator is out-of-round, commutator must be turned down in a lathe.
   a. Do not remove more material than is absolutely necessary to clean up commutator.
   b. Undercut mica between commutator bars 1/32" (.80mm). Undercutting must be done the full width of mica (leaving none along edges) and be flat at the bottom.
   c. Sand commutator lightly with 00 grit sandpaper to remove burns.

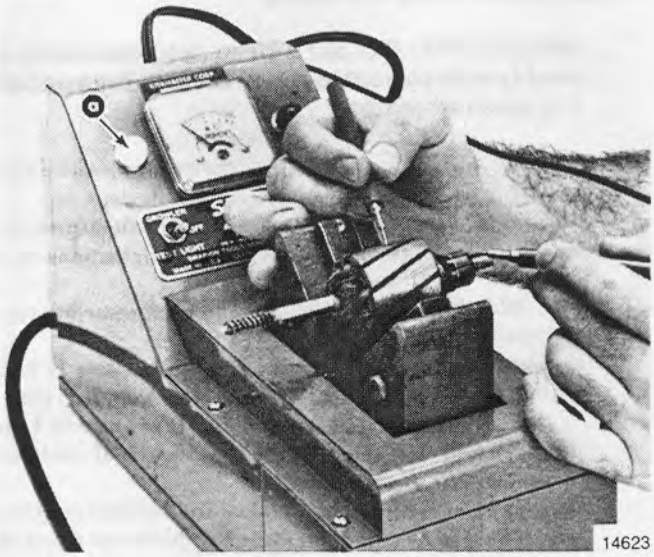
d. Clean grooves between commutator bars.
e. Test armature for shorts.

3. Inspect armature for scores on lamination. If the lamination is scored, the armature has been rubbing on pole shoes. This could be due to worn bushings, a bent armature shaft or loose pole pieces. Check armature for bent condition, using "V"-blocks and a dial indicator.
4. Inspect bushing surfaces on armature shaft for wear or scoring.
5. Inspect worm gear on end of shaft for wear, chipped teeth or other damage.
6. Inspect armature windings for visible damage (broken wires, heat discoloration, etc.)
7. Test armature windings for shorts, opens and grounds, using an armature growler, as follows:
   a. Test the armature for short circuits by placing on growler and holding hack saw blade over armature lamination while rotating armature. (Figure 8) If hack saw blade vibrates, armature is shorted. Recheck after cleaning between the commutator bars. If saw blade still vibrates, repalce the armature.

Figure 8. Testing Armature for Shorts

IMPORTANT: DO NOT place test leads on area of commutator where brushes ride, in the following tests, as arcing may damage commutator bars.

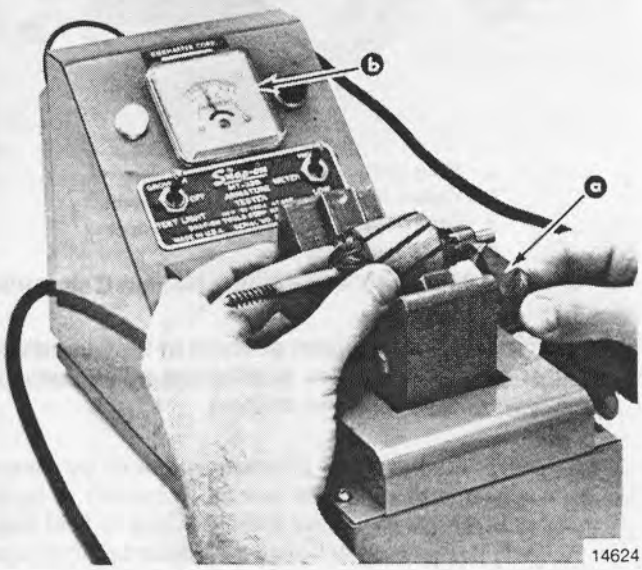
   b. Test the armature for grounded windings by placing one lead of growler continuity lamp on commutator (in an area where brushes do not ride) and other lead on lamination. (Figure 9) Move test lead around commutator while observing lamp. If continuity exists (lamp lites) armature windings are grounded and armature must be replaced.



a - Continuity Lamp

Figure 9. Testing Armature for Grounds

   c. Test armature windings for opens with growler hand piece. Adjust hand piece so that points contact adjacent commutator parts. With armature in growler and growler turned on, move hand piece around commutator until highest reading is obtained on ammeter. Hold hand piece in this position (relative to growler) and rotate armature while observing ammeter. (Figure 10) Ammeter readings between each successive set of commutator bars should be approximately the same. If not, replace armature.



a - Hand Piece b - Ammeter

Figure 10. Testing Armature for Opens

Switch-and-Drive Housing

IMPORTANT: DO NOT clean switch-and-drive housing with solvent as solvent may wash out lubricant impregnated in armature shaft bushings.

1. Clean all parts with a cloth.
2. Inspect switch plate for poor connections, loose, broken or worn contacts or a cracked insulator plate.
3. Inspect actuator arm for wear or scoring on bushing surface and for damaged threads.
4. Inspect switch and drive housing for cracks, damaged threads and scored actuator arm shaft and armature shaft bushings. Check bushings for wear by installing actuator arm and armature in bushings and checking side play. If play is excessive, housing must be replaced.
5. Inspect driven gear for worn or missing teeth, elongated slots (for drive washer) or other damage.
6. If switch plate-and-harness assembly or switch-and-drive housing require replacement, refer to "Component Replacement".

COMPONENT REPLACEMENT

Brush Replacement

1. Cut brush leads off as close to brush holders as possible.
2. Solder new brushes to brush holders, using 60-40 tin-lead alloy rosin core solder. Solder connection quickly to prevent solder from traveling up brush lead. Be sure solder does not ground out positive brush holder.

End Cap-and-Brush Assembly Replacement

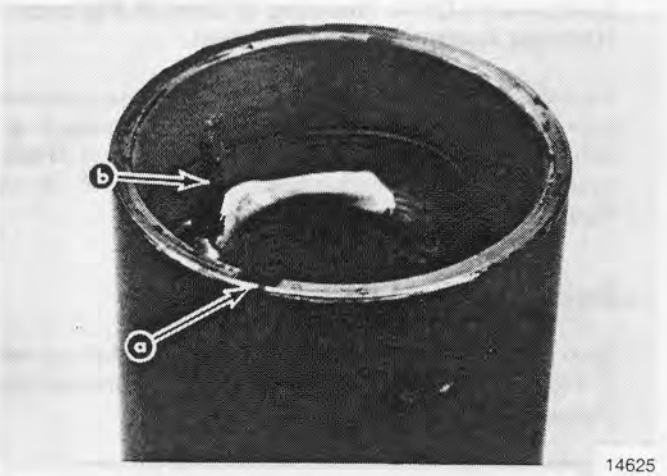
1. Cut off field positive brush holder lead as close to brush holder as possible.
2. Solder field lead to brush holder on new end cap, using 60-40 tin-lead alloy rosin core solder. Be sure solder does not ground out positive brush holder.

Field Coil Replacement

1. Cut off field to positive brush holder lead as close to brush holder as possible.
2. Use lacquer thinner to remove sealer from field lead terminals on switch plate, then unsolder field leads from switch. Pull field leads thru grommet in switch-and-drive housing and remove field-and-frame assembly.

IMPORTANT: Use extreme care to prevent distorting field frame when removing and installing pole shoe attaching screws, following. Use of a pole shoe spreader is recommended if an impact driver or an arbor press (to hold screwdriver bit down) is to be used.

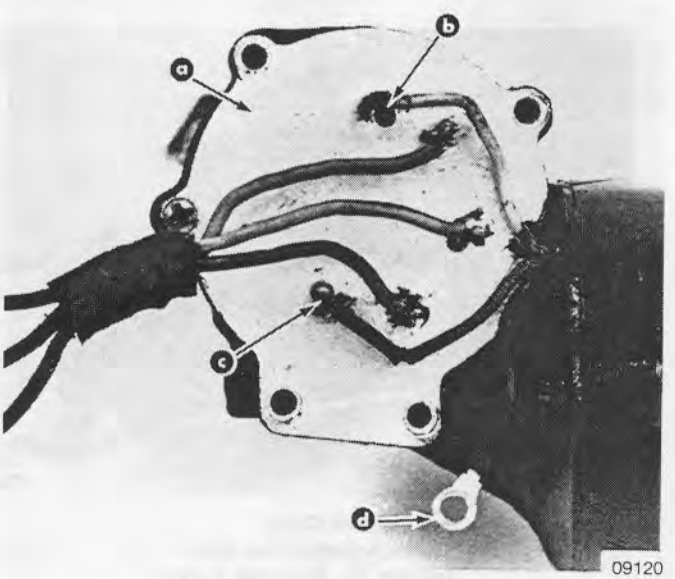
3. Remove 2 screws which secure pole shoes to field frame and remove field coil assembly and pole shoes.
4. Install poles shoes in new field coil assembly. Position coil and pole shoes in field frame with field to positive brush holder lead toward notched end of frame and adjacent to notch. (Figure 11) Install pole shoe attaching screws and torque to specifications. Strike field frame several times with a plastic or rubber hammer (to align and seat pole shoes) and recheck torque on attaching screws.



a - Notch
b - Field to Positive Brush Holder Lead

Figure 11. Field Coil Assembly Properly Positioned in Field Frame

5. Insert yellow, green and black field leads thru grommet in switch-and-drive housing. Straighten ears on switch plate terminals (from which leads were previously removed) Connect green and yellow field leads to terminals (as shown in Figure 12) and bend ears shut around leads to hold them in place. Solder connections with 60-40 tin-lead alloy rosin core solder.



a - Switch Plate
b - Yellow Field Lead
c - Green Field Lead
d - Black Field Lead (Ground)

Figure 12. Field Leads Connected to Switch Plate

6. Coat switch plate terminals with Liquid Neoprene.
7. Solder field lead (on commutator end) to positive brush holder, using 60-40 tin-lead alloy resin core solder.
8. Test field coil for opens and grounds as explained preceding.

Switch-and-Drive Housing or Switch Plate-and-Harness Assembly Replacement

Unsolder and resolder field leads to switch plate as explained under "Field Coil Assembly Replacement", preceding. If switch and harness assembly requires replacement, it will be necessarry to solder new harness to switch plate as shown in Figure 12.

Switch Pack (42528A2)

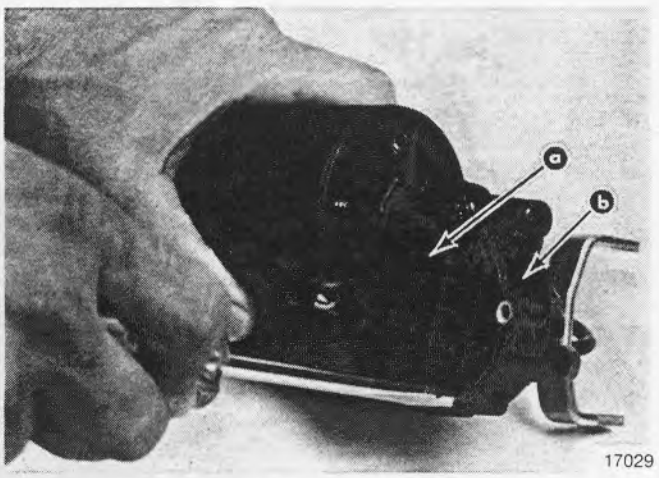
Switch Pack 42528A2 is a service kit for electric shift actuators. These instructions are for replacement of the original switch plate assembly.

⚠WARNING

Disconnect both battery cables at battery before attempting to install kit.

1. Remove the following.
   a. Remove electric shift actuator from boat.
   b. Remove and discard 5 screws and metal cover from actuator drive end. (Figure 13)

IMPORTANT: During rework, prevent foreign material from contaminating actuator drive gears.

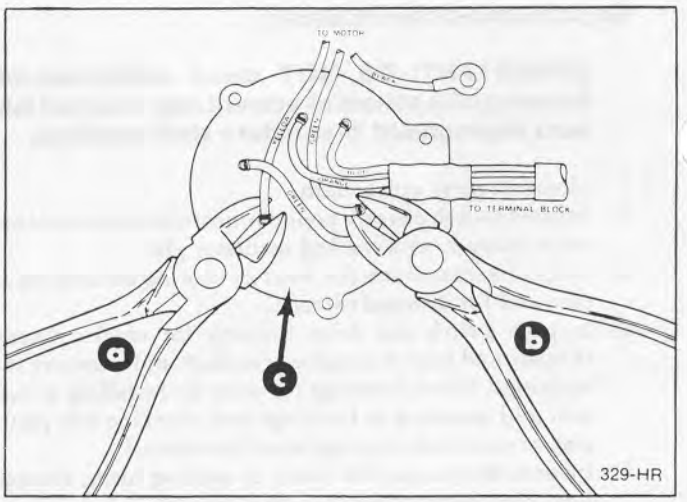


a - Metal Cover
b - Actuator Drive End

Figure 13. Remove Cover

IMPORTANT: The short green, yellow, and black leads from the actuator motor are required for installing the switch pack. Be careful not to shorten or sever them, nor to damage the insulation, during rework.

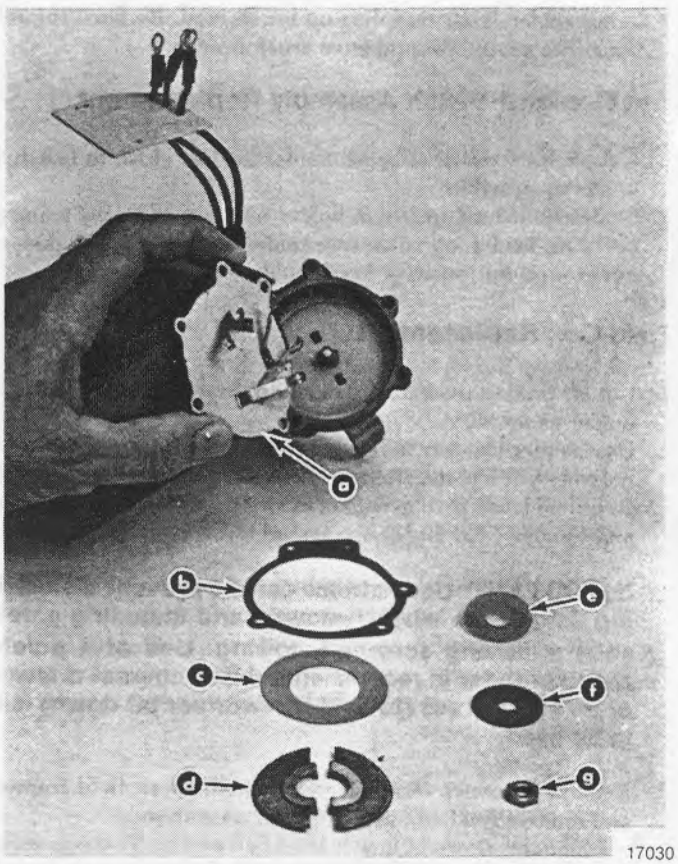
2. Locate actuator motor green and yellow leads on switch plate assembly. Scrape excess sealant from soldered contacts.
3. Clip green and yellow leads, with soldered contacts intact, as close to swtich plate as possible. (Figure 14) Carefully lift leads from switch plate, removing sealant as necessary to free them.



a - Yellow Lead
b - Green Lead
c - Switch Plate Assembly

Figure 14. Cutting Leads

4. Remove and discard switch plate assembly, with attached 3-wire harness, and gasket. (Figure 15)
5. Remove the nut, metal washer, plastic insulating washer, two brass contact plates and large, thin insulating washer from actuator. Retain nut, discard other parts. (Figure 15)

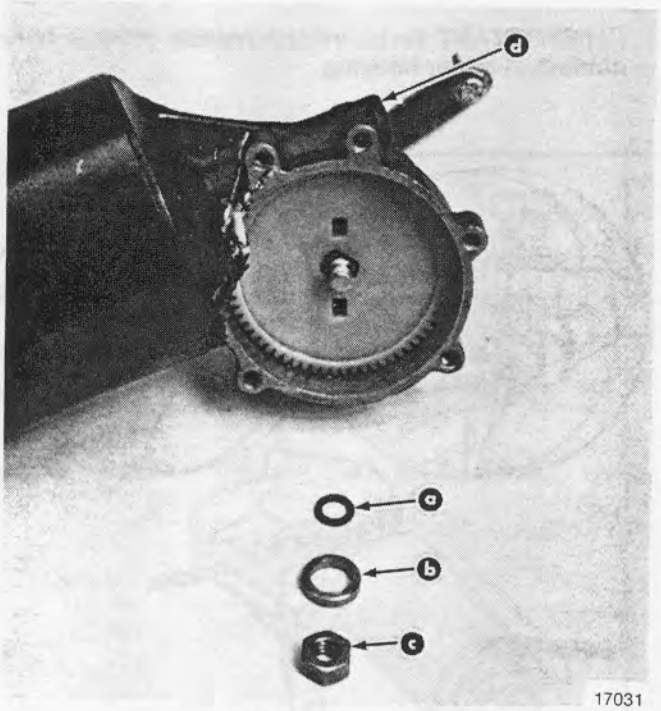


a - Switch Plate Assembly & Harness
b - Gasket
c - Insulating Washer
d - Brass Contact Plates
e - Plastic Washer
f - Metal Washer
g - Nut - Retain

Remove and Discard

Figure 15. Removing Parts

6. Assemble small "O" ring and spacer from kit on threaded end of actuator crank arm. Secure with nut retained in Step 5. Torque to spcification (Figure 16)
7. Adjust worm gear backlash. Turn worm gear screw in until it bottoms. Then loosen approximately ¼ turn. (Figure 16)



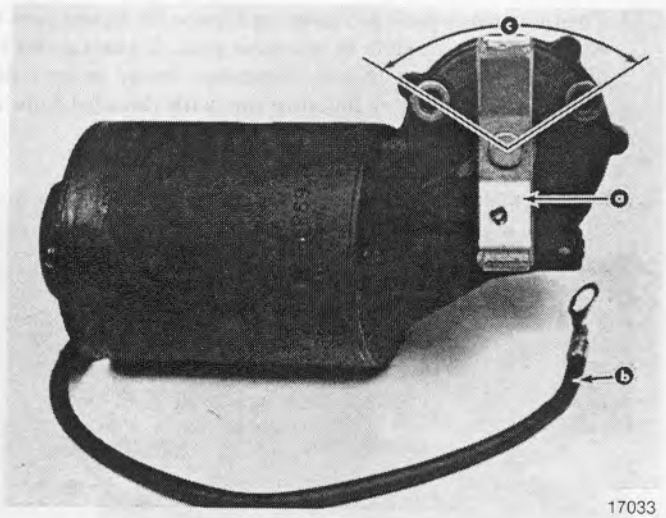
a - "O" Ring
b - Spacer
c - Nut
d - Worm Gear Screw

Figure 16. Assembly

8. Determine that crank arm is positioned within shift range as shown in Figure 17.
9. If not, connect actuator ground wire to negative (-) battery terminal. Contact actuator yellow or green lead to positive (+) battery terminal until crank arm moves within shift range.

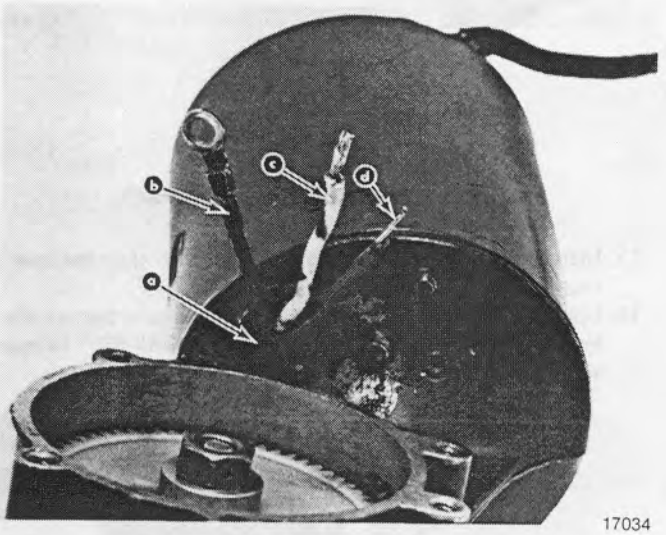
IMPORTANT: Arm for actuator is symmetrical and either end can be located within indicated shift range.

10. Scrape excess sealant from actuator motor where green, yellow, and black leads exit. Be careful not to damage lead insulation or grommet. DO NOT push in or pull out leads.
11. Prepare green and yellow leads for later attachment to terminals. Clip off soldered ends and strip insulation back approximately ½" (13mm). Scrape varnish from green lead solid core. Each lead should be a minimum length of 1½" (38mm). (Figure 18)
12. Position leads as shown, so they are not pinched when installing switch pack. Coat grommet with Liquid Neoprene.



a - Crank Arm
b - Ground Wire
c - Shift Range

Figure 17. Crank Arm Position



a - Grommet
b - Black Lead
c - Yellow Lead
d - Green Lead

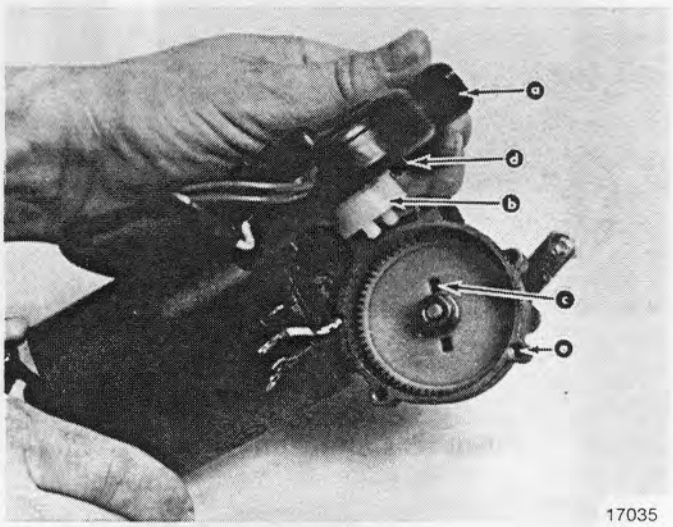
Figure 18. Preparing Leads

IMPORTANT: Before installing switch pack be sure that actuator gear is free of foreign material.

13. Remove clip or rubber band (as applicable) from switch pack. Do not separate two halves of switch pack assembly.

IMPORTANT: DO NOT use excessive force when adjusting switch pack cam position. Cam does not rotate 360°.

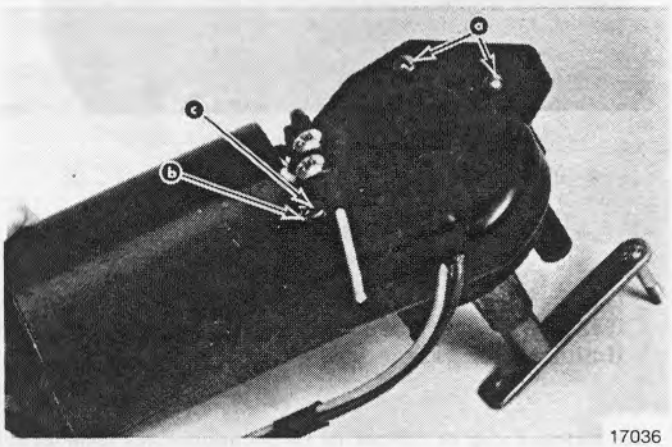
14. Position switch pack as shown in Figure 19. Rotate cam to align prongs with slots in actuator gear. If cam cannot be aligned by rotating in one direction, rotate in opposite direction. Align outer locating pin with threaded hole in actuator and snap switch pack into place.



a - Switch Pack
b - Cam
c - Gear
d - Outside Pin
e - Threaded Hole

Figure 19. Position Switch Pack

15. Install two 1" (25mm) screws through thin section of switch pack. Do not tighten. (Figure 20)
16. Install 1" (25mm) spacer into remaining hole. Secure black lead (with ring terminal) from motor with 1⅜" (35mm) screw. Tighten three screws securely. (Figure 20)

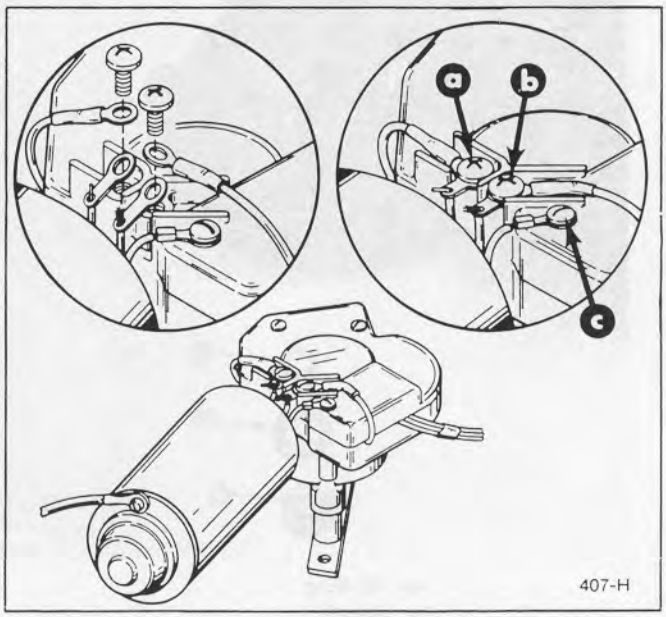


a - 1" (25mm) Screws
b - Spacer
c - 1-3/8" (35mm) Screw - Black Lead

Figure 20. Installing Screws/Spacer

17. Insert motor yellow lead thru terminal eyelet (from kit). Fold over wire as shown. Insert self-trapping screw (from kit) thru both yellow lead terminals; install into hole on switch pack. Clip off excess wire. (Figure 21)
18. Solder with 60/40 resin core solder. Do not use excessive heat. Tighten securely.
19. Repeat for green leads from motor and switch pack.

IMPORTANT: Be sure ring terminals or wires do not contact motor housing.



a - Green Leads
b - Yellow Leads
c - Black Lead

Figure 21. Connecting Leads

20. Install blue and green heat shrink sleeves to appropriate switch pack terminals as shown in Figure 22. Use suitable heat source to shrink sleeves.
21. Check operation of actuator by connecting actuator ground wire to negative (-) battery terminal and individually contacting blue, orange and green leads, one at a time, to positive (+) battery terminal.
22. Reposition crank arm of actuator for ease of installation in boat. Contact blue lead to positive (+) battery terminal until arm is in reverse position.

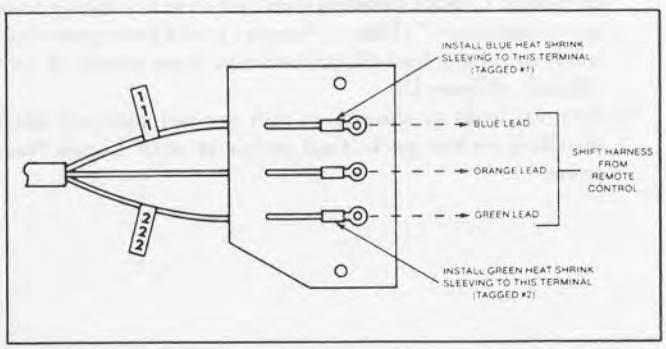
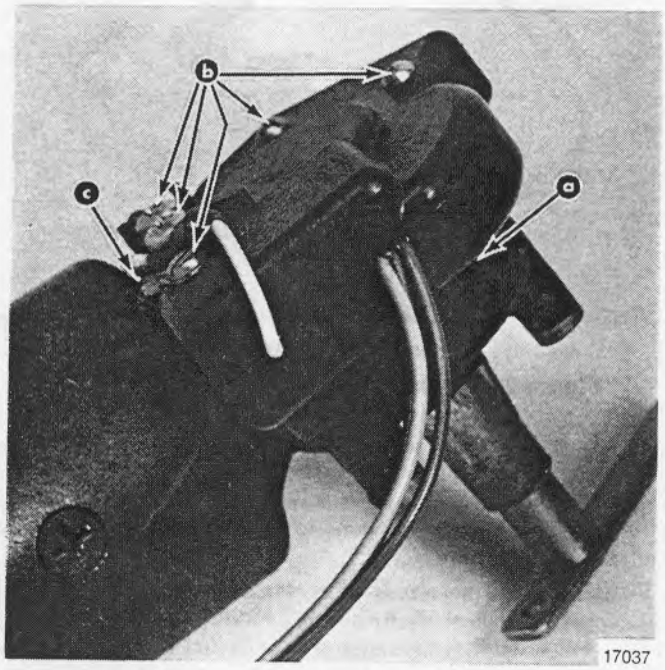


Figure 22.

IMPORTANT: Liquid Neoprene must be applied to worm gear screw to prevent screw from moving.

23. Apply Liquid Neoprene to the following areas: All screws, ring terminals, worm gear screw, mating split line of actuator, and switch pack cavity where leads exit motor. (Figure 23)



a - Mating Split Line
b - Screws
c - Cavity

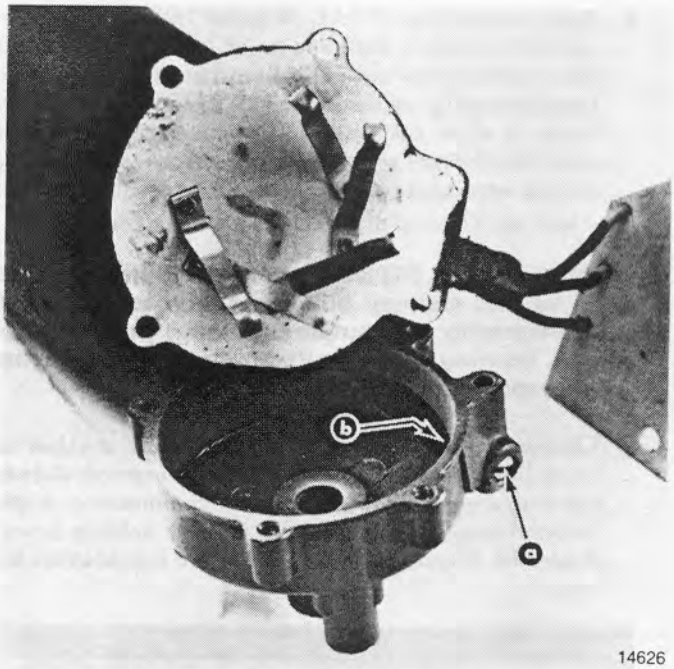
Figure 23. Apply Liquid Neoprene

24. Reinstall electric shift actuator in boat.
25. Connect both battery cables to proper terminals.
26. Check shift operation to assure proper engagement of forward, neutral, and reverse.

REASSEMBLY

IMPORTANT: Shift motor and actuator must be water tight or internal corrosion damage may result during operation. Make sure that all mating surfaces are sealed with Liquid Neoprene.

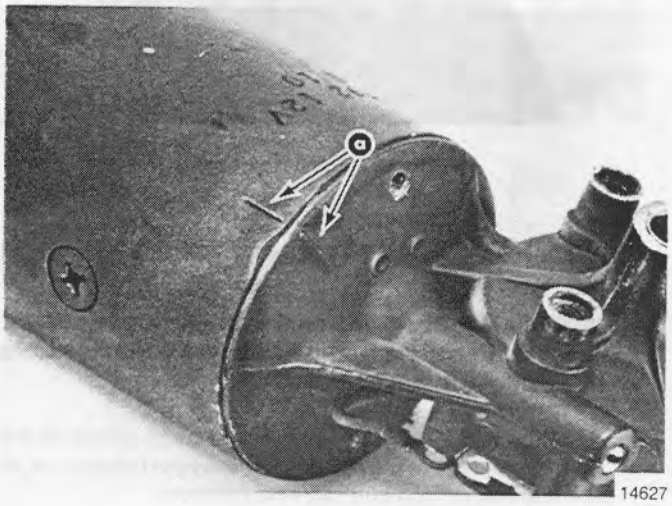
1. Lubricate armature end thrust washer with 2-4-C Multi-Lube and insert into cavity in switch and drive housing. (Figure 24)
2. If a new armature is to be installed, turn armature end play adjusting screw (Figure 24) counterclockwise approximately 2 turn.



a - Armature End Play Adjusting Screw
b - Armature End Thrust Washer (Hidden)

Figure 24. Armature End Play Adjusting Screw and End Thrust Washer

3. Apply Liquid Neoprene to field frame mating surface on switch-and-drive houisng and place field-and-frame asembly onto housing. Position field-and-frame assembly onto housing. Position field-and-frame assembly so that index marks align. (Figure 25)



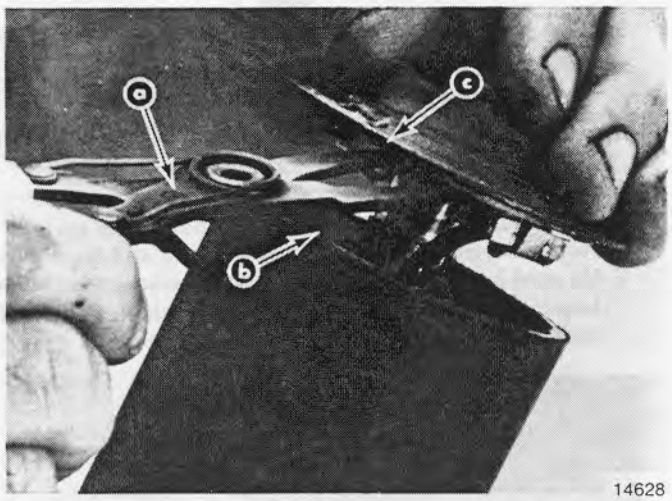
a - Index Marks

Figure 25. Housing and Frame Index Marks Aligned

4. Apply a light film of SAE 10 motor oil to bushing area on end of armature shaft and install armature in field-and-frame assembly and switch-and-drive housing. Leave armature protruding approximately 1" (25mm) above field frame to allow easy installtion of end cap-and-brushes assembly. Support armature in this position by inserting a suitable object between armature and end thrust washer.
5. Apply one (1) drop of SAE 10 into bushing in end cap.

IMPORTANT: DO NOT apply more than one drop of oil into end cap bushing as excess oil will be thrown onto commutator, causing poor conduction, burning of commutator bars and subsequent poor motor performance.

6. Clean brushes and install brush springs and brushes into brush holders. While holding brushes depressed, slide end cap onto armature and brushes over commutator. A small external snap ring pliers works well for holding brushes depressed. (Figure 26) Be careful not to mar brushes with pliers.



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a - External Snap Ring Pliers
b - Notch
c - Locating Boss

Figure 26. Installing End Cap and Brushes Assembly

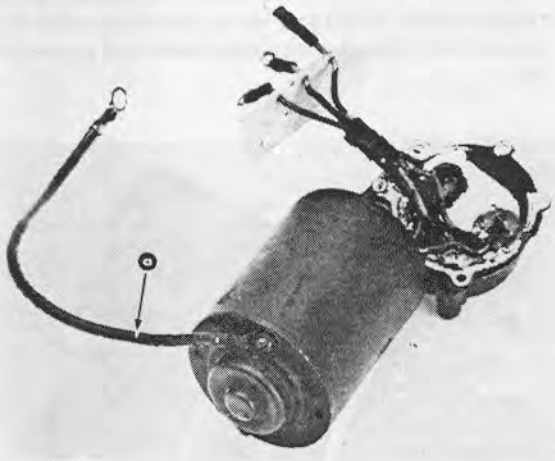
IMPORTANT: Position positive brush lead so that it will not contact field frame when end cap is lowered into position, in next step.

7. Apply Liquid Neoprene to end cap mating surface on field frame, then remove object used to support armature and lower armature and end cap into position.

IMPORTANT: Be sure index marks on field frame and switch-and-drive housing (Figure 25) are aligned before torquing thru-bolts, in next step.

8. Align locating boss on end cap with notch in field frame (Figure 26) and install thru-bolts, lockwashers and ground wire. Posiiton ground wire as shown in Figure 27. Torque thru-bolts to specification. Apply Liquid Neoprene to ground wire connection.

IMPORTANT: When installing actuator arm, in next step, arm must be positioned within range shown in Figure 28. This is necessary to ensure proper phasing of switch.



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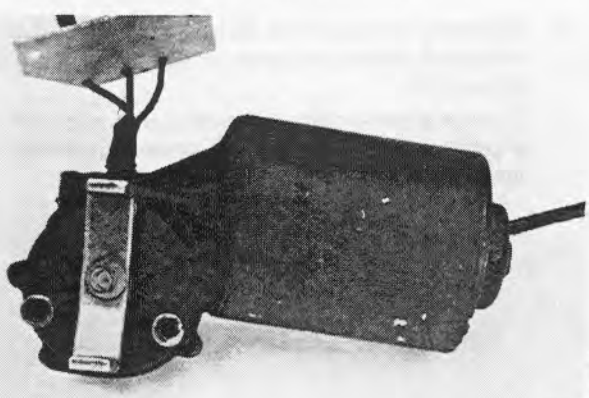
a - Ground Wire

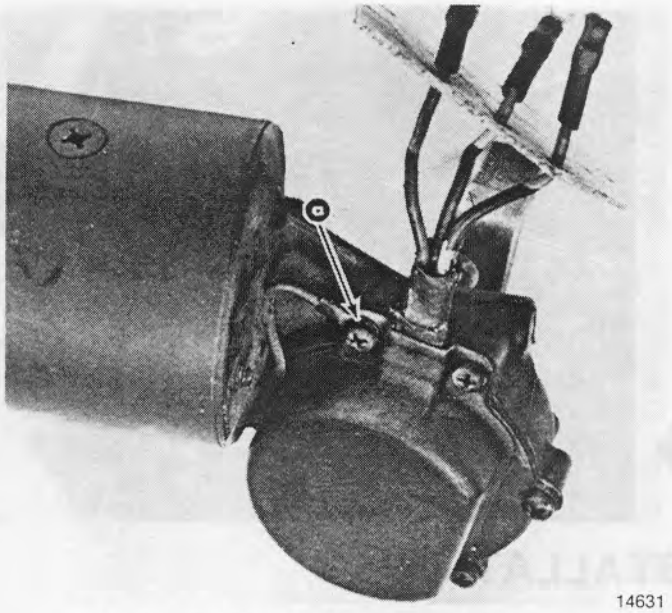
Figure 27. Ground Wire Properly Positioned

9. Adjust armature end play by turning adjusting screw on switch plate-and-drive housing (Figure 24) in until it bottoms-out, then back screw out ⅛ to ¼ turn. Coat screw head with Liquid Neoprene to prevent it from loosening during operation.
10. Lubricate armature shaft worm gear, driven gear and actuator arm shaft with 2-4-C Multi-Lube. Place small nylon washer on actuator arm shaft and install actuator arm in switch-and-drive housing. Install drive washer (with tabs out), driven gear (with lettered side down), large nylon washer, 2 brass plates (with tabs inserted into slots in gear), insulating washer (with tabs inserted between brass plates) and metal washer. Secure all parts with new locknut. Torque nut to specifications.
11. Apply a thin film of 2-4-C Multi-Lube to contact surface of brass plates.
12. Install switch plate on switch-and-drive housing with a new gasket in-between.
13. Pull on yellow, green and black field leads to remove slack from interior of motor, then apply Liquid Neoprene to grommet where field leads pass thru housing. Apply Liquid Neoprene to switch plate cover mating surface on switch plate and wires. Install cover, being sure to connect black field lead to appropriate screw. (Figure 29) Tighten cover and switch plate attaching screws securely.



14630

Figure 28. Positioning Actuator Arm



a - Black Field Lead (Coat with Liquid Neoprene)

Figure 29. Black Field Lead Connected

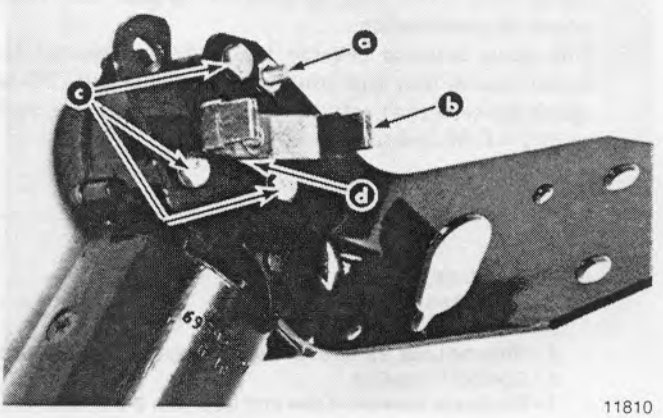
14. Apply Liquid Neoprene to black field wire connection and to any other area on shift actuator where metal has been exposed.

INSTALLATION

1. Install actuator arm stop screw in shift actuator mounting bracket and secure with locknut. (Figure 30)

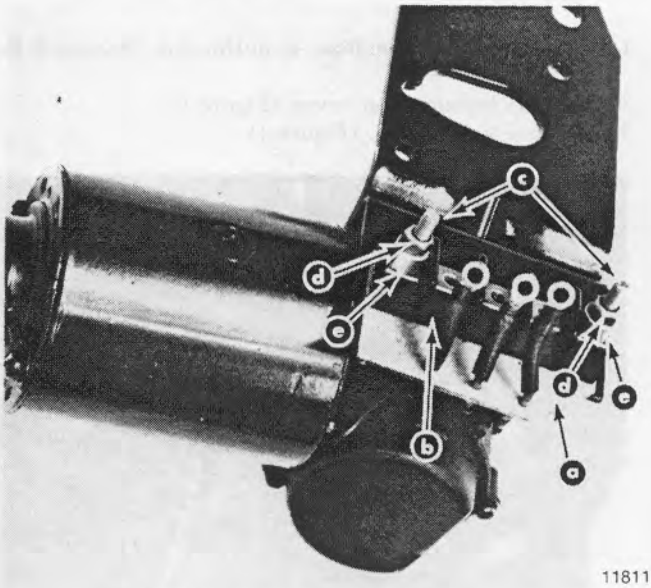
   IMPORTANT: When moving shift actuator arm, in next step, leave shift motor leads attached to battery until shift actuator has completed its cycle. Failure to do this, may allow arm (and switch) to coast beyond forward or reverse limits which may cause shift motor to become inoperative.

2. Apply Loctite "A" to threads of shift actuator attaching screws. Attach actuator to mounting bracket with screws and lockwashers. (Figure 30) Torque screws to specifications. It will be necessary to move actuator arm to install all 3 screws. Do so, by connecting shift motor ground (black) lead to negative (-) battery terminal and green, blue or orange shift motor lead to positive (+) battery terminal.
3. Attach shift motor leads support plate and terminal block to mounting bracket with screws, lockwashers, spacers and locknuts, as shown in Figure 31. Torque locknuts to specifications.



a - Actuator Arm Stop Screw and Locknut
b - Actuator Arm
c - Shift Actuator Attaching Screws and Lockwashers
d - Fill Space Between Actuator Arm and Housing with 2-4-C Multi-Lube

Figure 30. Shift Actuator Attached to Mounting Bracket



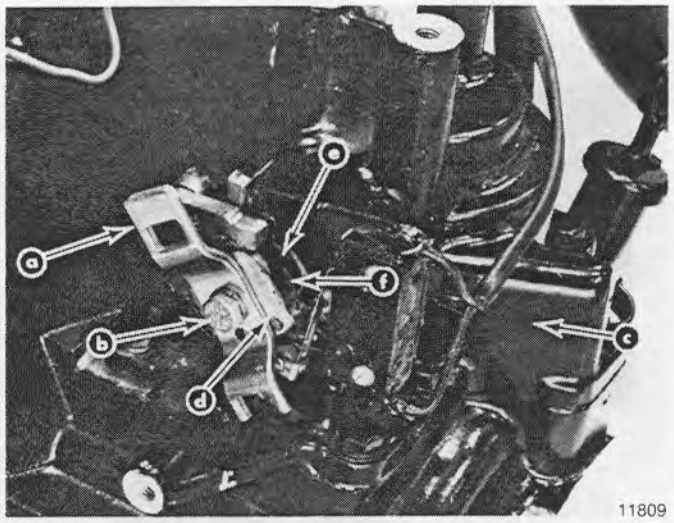
a - Shift Motor Leads Support Plate
b - Terminal Block
c - Screws - Lockwashers on Head on Screw
d - Locknuts
e - Spacers

Figure 31. Terminal Block and Shift Motor Leads Support Plate Attached to Mounting Bracket

4. If removed, attached shift link to transmission control valve with screw and lockwasher. (Figure 32) Torque screw to specifications.
5. Fill space between reverse lock valve-and-neutral start safety switch cam and control valve cap (Figure 32) and space between shift actuator arm and housing (Figure 30) with 2-4-C Multi-Lube.

a - Shift Link
b - Screw and Lockwasher
c - Transmission Control Valve
d - Reverse Lock Valve-and-Neutral Start Safety Switch Cam
e - Control Valve Cap
f - Fill Space Between Cam and Cap with 2-4-C Multi-Lube

Figure 32. Shift Link Installed on Control Valve

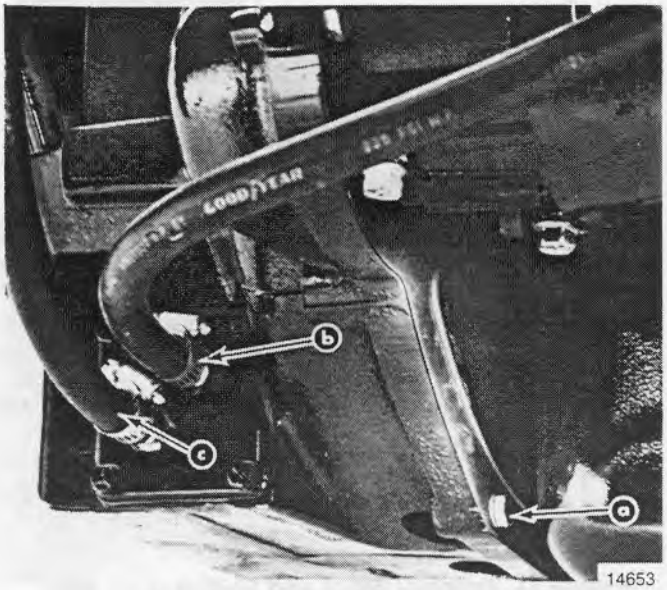


11809

REMOVAL/INSTALLATION

TRANSMISSION REMOVAL

1. Remove engine from boat, as outlined in "Section 2, Part F".
2. Remove transmission cover. (Figure 1)
3 Remove water hoses. (Figure 1)

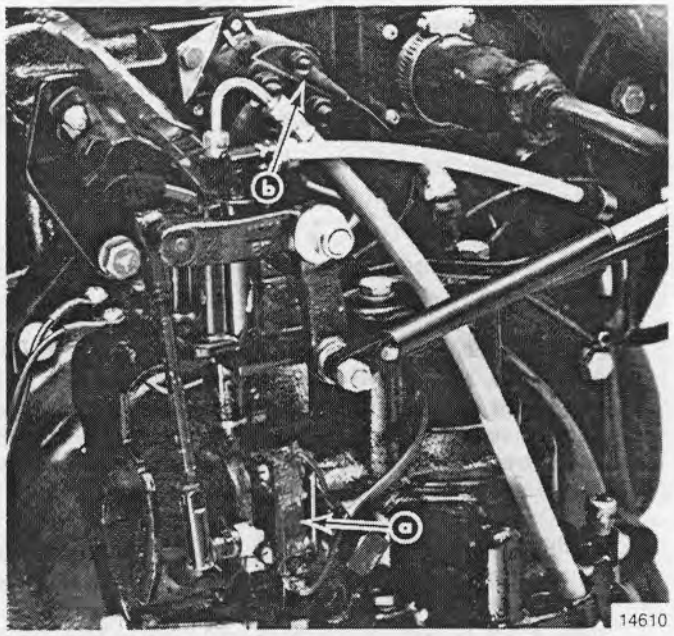


14653

a - Cover Screws/Lockwashers (4)
b - Water Inlet Hose
c - Water Outlet Hose (To Exhaust Elbow)

Figure 1. Removing Cover and Hoses

4. Disconnect neutral start safety switch wire from slave solenoid. (Figure 2)
5. Remove any brackets, clamps or wires attached to transmission that will prevent removal of transmission.
6. Remove transmission attaching screws ansd washers, then pull transmisssion straight back and off engine.



14610

a - Neutral Start Safety Switch
b - Switch wire - Going to Solenoid

Figure 2. Neutral Switch Wire

TRANSMISSION INSTALLATION

1. Lubricate input shaft with 2-4-C Multi-Lube.
2. Align input shaft splines with engine drive plate splines and push transmission straight ahead onto engine. Secure transmission with 6 screws and washers. Torque screws to specifications.
3 Connect any brackets, clamps or wires removed in Step 5, of "Removal".
4. Connect water inlet and outlet hoses to oil cooler and secure with hose clamps. (Figure 1)
5. Install transmission housing cover. (Figure 1) Torque to specifications.

6. Connect neutral start safety switch lead to starter slave solenoid. (Figure 2) Tighten nut securely and coat connection with Liquid Neoprene.
7. Install engine in boat as explained in "Section 2, Part F".

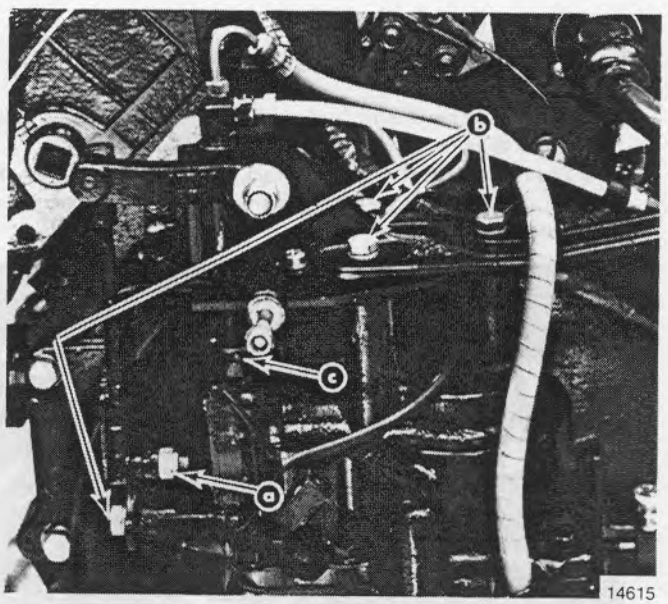
IMPORTANT: Before installing stern drive unit, be sure to lubricate transmission output shaft splines and output bearing with 2-4-C Multi-Lube.

If not already done, fill transmission with recommended automatic transmission fluid.

MECHANICAL SHIFT COMPONENT REMOVAL

1. If not already done, remove shift cable.
2. Disconnect shift rod by removing nut. (Figure 3)
3. Remove 4 screws and lockwashers that secure mounting bracket to control valve. (Figure 3)
4. Remove reverse lock valve and mounting bracket.

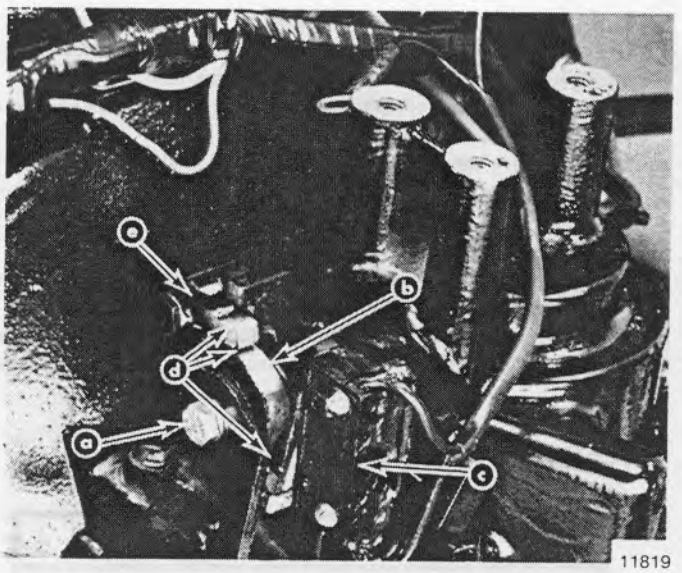
NOTE: If hydraulic hoses are still connected, just lay valve and bracket out of the way.



a - Nut - Shift Rod
b - Screws/Lockwashers (4)
c - Plunger on Cam Follower

Figure 3. Removing Bracket

5. Remove screw and lockwasher that secures shift lever to control valve cam. (Figure 4)
6. If required, remove neutral start safety switch. (Figure 4)

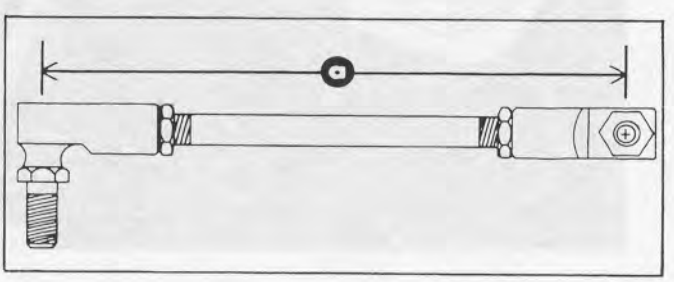


a - Screw/Lockwasher - Shift Lever
b - Cam
c - Neutral Start Safety Switch
d - Lubricate with 2-4-C Multi-Lube
e - Cam Follower

Figure 4. Lever and Switch

MECHANICAL SHIFT COMPONENT INSTALLATION

IMPORTANT: Transmission shift rod assembly is preset to dimension shown in Figure 5 and must not be changed. Check dimension to ensure that it has not been changed.



a - 5-1/32" (128mm)

Figure 5. Transmission Shift Rod Dimension

1. Lubricate areas shown in Figure 4.
2. If removed, attach shift lever (to cam) with screw and lockwasher. Torque screw to specifications.
3. If removed, install neutral start safety switch as shown in Figure 4.
4. Make sure cam follower is positioned as shown in Figure 4.
5. Place reverse lock valve and mounting bracket on control valve with reverse lock valve plunger contacting cam follower. (Figure 3)
6. Move mounting bracket right or left until plunger is centered on cam follower. Tighten screws securely.
7. Reconnect shift rod to shift lever. (Figure 3) Tighten nut.
8. Attach and adjust shift cable as outlined in "Section 2, Part F".

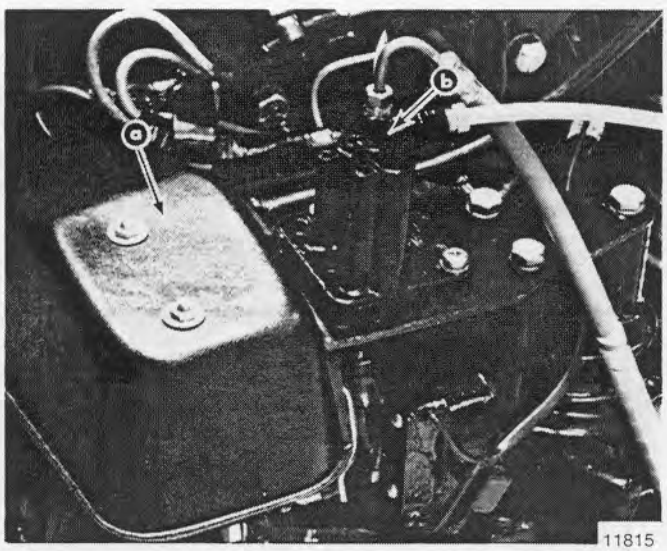
ELECTRIC SHIFT COMPONENT REMOVAL

⚠CAUTION

Disconnect both battery cables BEFORE proceeding.

1. Remove cover. (Figure 6)
2. Remove reverse lock valve. (Figure 6)

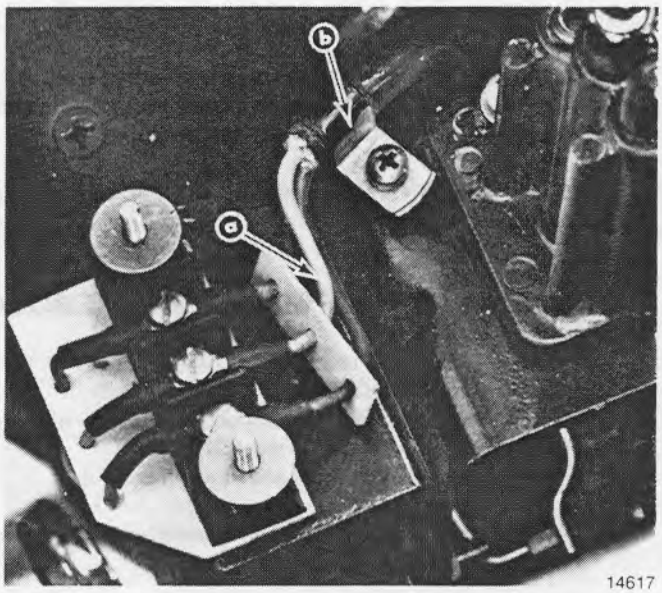
NOTE: If hydraulic hoses are still connected, just lay valve out of the way.



a - Cover
b - Reverse Lock Valve

Figure 6. Cover and Reverse Lock Valve

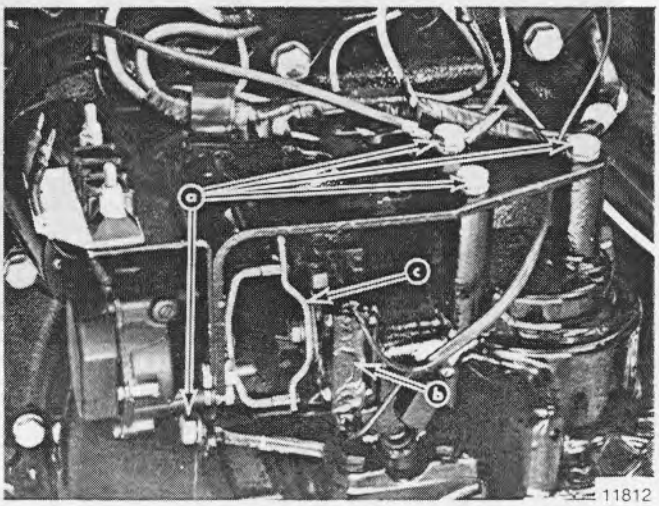
3. Disconnect remote control harness wires. (Figure 7)
4. Remove clamp that secures harness to bracket. (Figure 7)



a - Harness Wires b - Clamp

Figure 7. Harness

5. Remove 4 screws and lockwashers that secure mounting bracket to control valve. (Figure 8) Remove bracket.
6. If required, remove neutral start safety switch. (Figure 8)
7. If required, remove shift link from cam on control valve. (Figure 8)

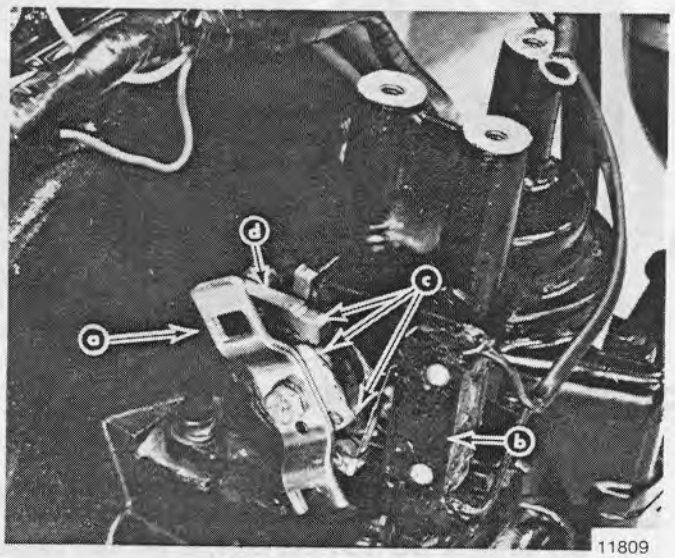


a - Screws/Lockwashers (4) b - Neutral Start Safety Switch
c - Shift Link

Figure 8. Removing Bracket

ELECTRIC SHIFT COMPONENT INSTALLATION

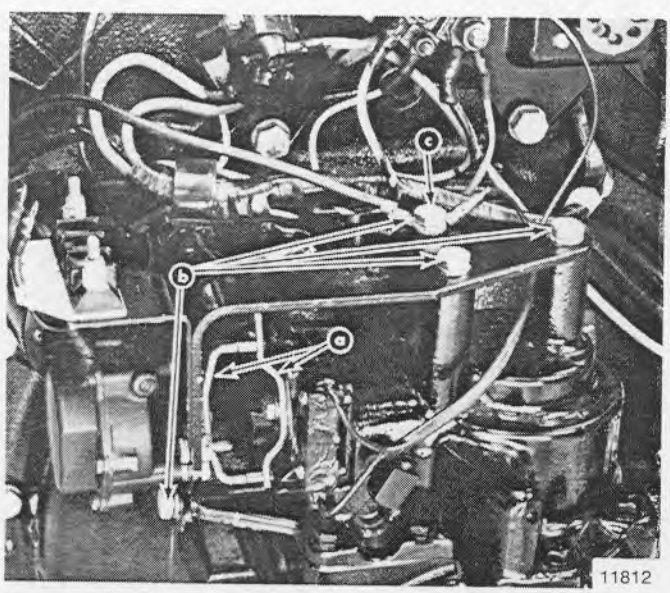
1. If removed, install shift link to cam. (Figure 9)
2. If removed, install neutral start safety switch. (Figure 9)
3. Lubricate areas shown in Figure 9.
4. Position shift link as shown in Figure 9.
5. Make sure cam follower is as shown in Figure 9.



a - Shift Link - In Reverse Gear
b - Neutral Start Safety Switch
c - Lubricate with 2-4-C Multi-Lube
d - Cam Follower

Figure 9. Link and Switch

6. Shift actuator into reverse gear by connecting motor ground (black) wire to negative (-) battery terminal and motor blue wire to positive (+) battery terminal. Allow motor to complete its cycle.
7. Hold shift actuator and mounting bracket in position along side control valve. Align shift link with actuator arm, then slide actuator-and-bracket into place and secure bracket (and ground wires) with 4 screws and lockwashers. (Figure 10) Attach shift motor ground wire and neutral safety switch ground wire to screw, as shown. Tighten screws finger tight only at this time.



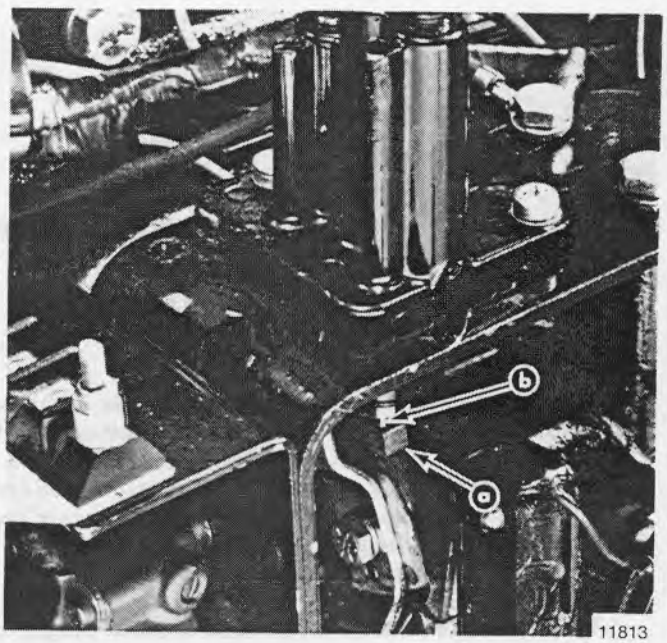
a - Link and Arm Aligned - Longer ends
b - Screws/Lockwashers (4)
c - Motor and Neutral Switch Ground Wires - Coat with Liquid Neoprene

Figure 10. Actuator/Bracket Installed

8. Coat reverse lock valve plunger with 2-4-C Mult-Lube.

IMPORTANT: Cam follower must be positioned as shown in Figure 9 BEFORE installing reverse lock valve.

9. Install reverse lock valve. Torque to specifications. (Figure 11)
10. Move mounting bracket right or left until plunger is centered on cam follower. Torque 4 screws to specifications.



a - Cam Follower
b - Plunger - Centered on Cam Follower

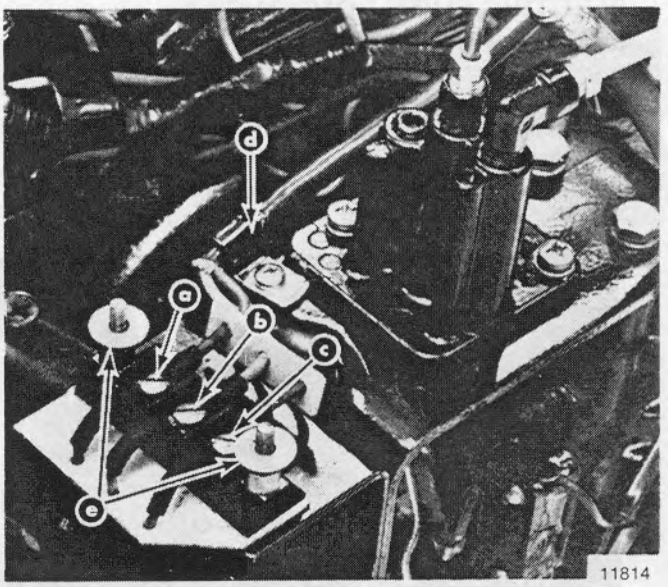
Figure 11. Reverse Lock Valve Installed

11. Reconnect remote control harness wires to terminal block as shown in Figure 12. Coat connections with Liquid Neoprene.

IMPORTANT: Color coded wires must match (blue to blue, etc.) or transmission failure WILL OCCUR.

12. Attach harness clamp to bracket. Tighten screw securely. (Figure 12)

13. Place one flat washer on each terminal block attaching screw (Figure 12), then install shift motor cover and secure with 2 flat washers, lockwashers and nuts. (Figure 6) Tighten nuts securely.
14. Reconnect battery cables to battery.



a - Blue Wires
b - Orange Wires
c - Green Wires
d - Harness Clamp
e - Washers

Figure 12. Wire Connections

TRANSMISSION REPAIR PRECAUTIONS

The transmission repair procedures are outlined in 5 subassemblies: Output Housing; Control Valve Housing; Gerotor Pump; Planetary Assembly; and Transmission Housing. It may not be necessary to repair all of the subassemblies in every case, however, if gerotor pump or any of the bearings or gears have failed, ALL of the subassemblies should be serviced to remove any metal particles and inspect for damage.

IMPORTANT: Use Loctite 242 Blue on all plugs, cap screws and nuts. Using any other type of Loctite or sealant may cause fluid leaks. Threads in aluminum casting should be primed with Loctite Primer N.

IMPORTANT: Let all Loctite sealants cure 24 hours before operating transmission.

IMPORTANT: All transmission parts should be thoroughly cleaned with soivent. Use compressed air to dry all parts. DO NOT use rags, as lint may cause a transmission malfunction.

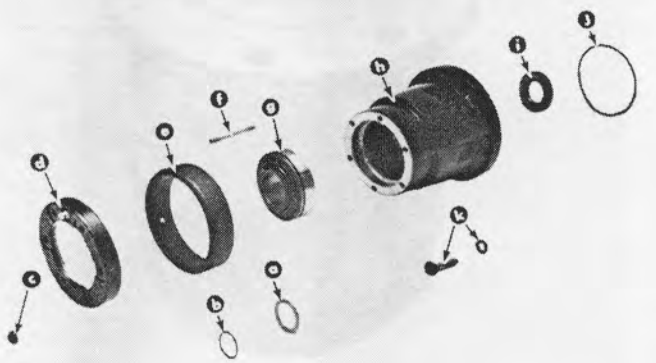
IMPORTANT: All O-rings, seals and teflon seal rings must be replaced.

IMPORTANT: Clean all sealing surfaces before reassembly.

IMPORTANT: Coat all seal lips and "O" rings iwth transmission fluid during reassembly.

OUTPUT HOUSING REPAIR

NOTICE
Refer to "Repair Precautions" BEFORE proceeding.



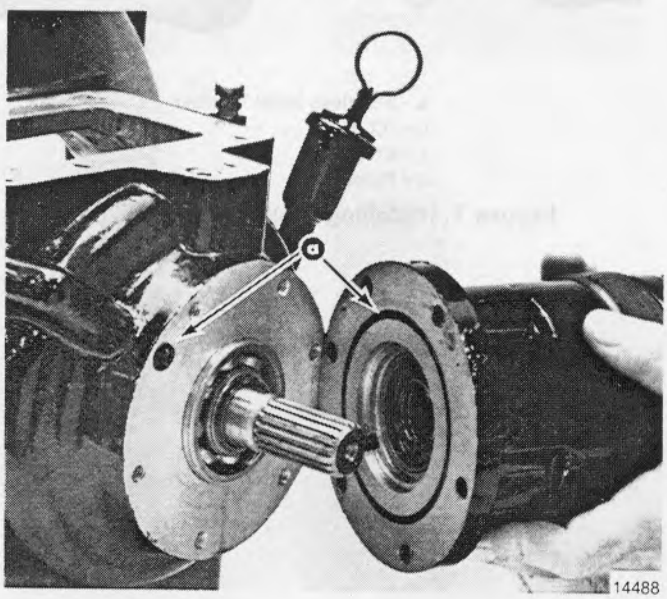
14511

a - Stainless Steel Washer (1) - Output Shaft
b - "O" Ring (1) - Output Shaft
c - Nut (6)
d - Retainer
e - Rubber Mount
f - Stud (6)
g - Bearing
h - Output Housing
i - Oil Seal
j - "O" Ring
k - Screws/Lockwashers (6)

Figure 1. Output Housing

REMOVAL/DISASSEMBLY

1. Remove attaching screws and washers, then remove output housing. (Figure 1) Remove stainless steel washer and "O" ring laying loose inside housing.
2. Remove and discard 2 "O" rings. (Figure 2)

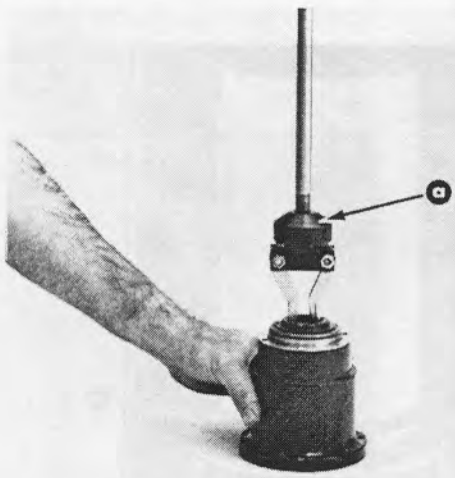


14488

a - "O" Rings

Figure 2. Removal

3. Remove nuts, retainer and rubber mount.
4. Remove oil seal.
5. Remove bearing. (Figure 3)



14636

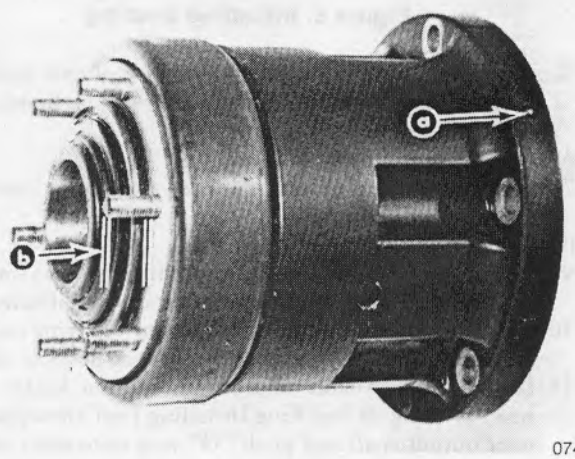
a - Slide Hammer Puller

Figure 3. Removing Bearing

6. Clean and inspect all parts. Replace damaged parts.

REASSEMBLY/INSTALLATION

1. If removed, apply Loctite 242 Blue to new sealing ball and install in oil passage with a drift and hammer. (Figure 4)



07465

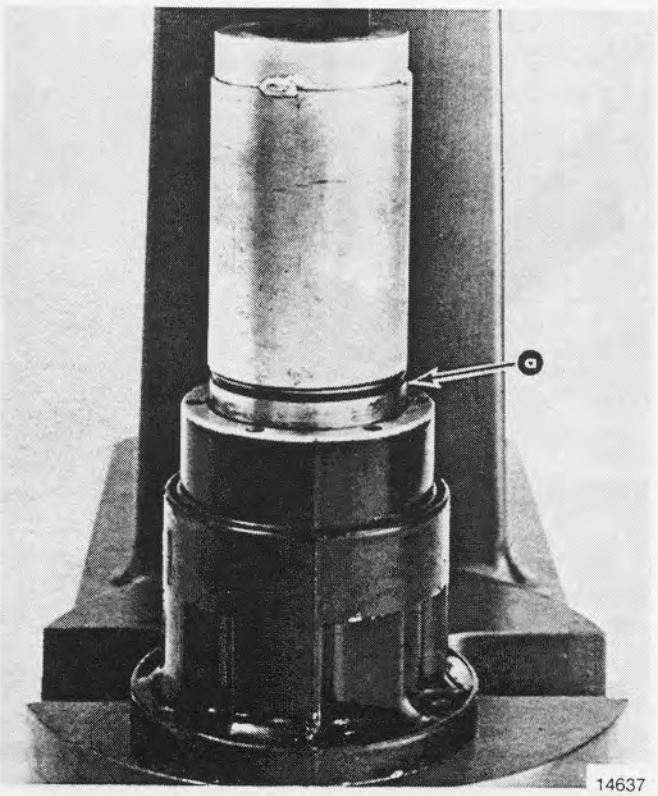
a - 3/16" Diameter Sealing Ball
b - 5/8" (16mm)

Figure 4. Sealing Ball and Studs

2. If removed, apply Loctite "A" to threads of studs and install. (Figure 4)
3. Apply 2-4-C Multi-Lube to bearing bore in housing.

IMPORTANT: Press on outer race of bearing.

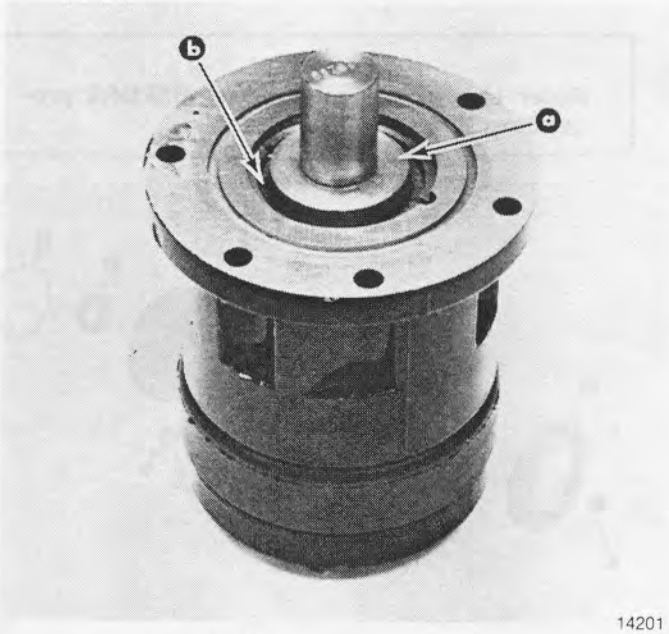
4. Press bearing (with grease groove out) into housing. (Figure 5)



a - Grease Groove

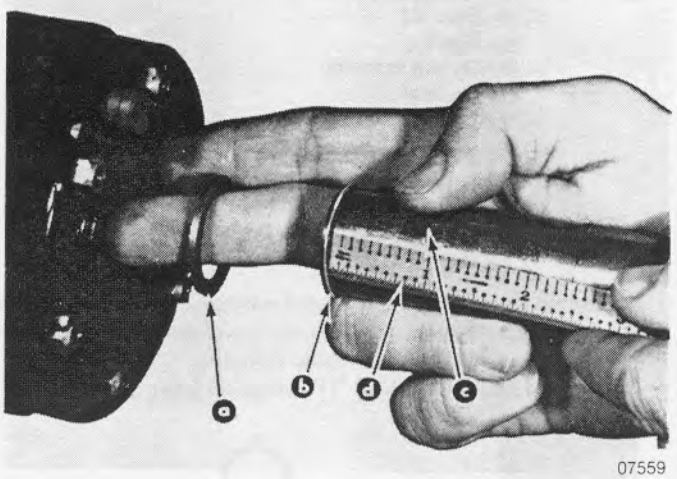
Figure 5. Installing Bearing

5. Apply Loctite "A" to outside diameter of new seal. With seal lip facing toward transmission, press into housing with Seal Installing Tool. (Figure 6)
6. Place rubber mount on housing.
7. With grease fitting upward (when housing is installed), install retainer and nuts.
8. Install new "O" rings. (Figure 2)
9. Install output housing (with grease fitting up) to transmission. Torque screws and lockwashers to specifications.
10. Install stainless steel washer and then "O" ring onto output shaft. Push both onto shaft as far as possible with
11. Install stainless steel washer onto output shaft. Install new "O" ring on Seal Ring Installing Tool, then place tool over output shaft and push "O" ring onto shaft, using a small ruler. Use Installing Tool to push "O" ring onto shaft as far as possible. (Figure 7)



a - 91-68762
b - Seal Lip Toward Transmission

Figure 6. Installing Seal



a - Stainless Steel Washer
b - "O" Ring
c - 91-65303
d - Ruler

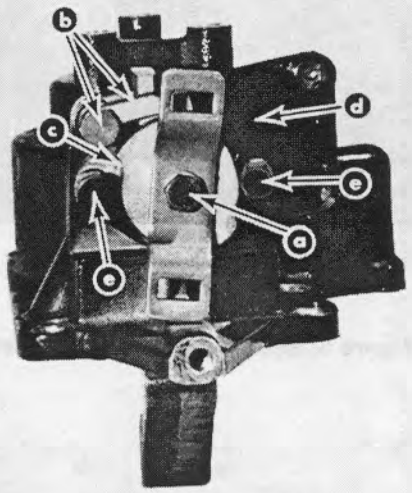
Figure 7. Installing Washer and "O" Ring

CONTROL VALVE HOUSING REPAIR

NOTICE
Refer to "Repair Precautions" BEFORE proceeding.

REMOVAL/DISASSEMBLY

1. Remove the following:
   a. **Electric Shift Models:** Shift actuator.
   b. **Mechanical Shift:** Shift linkage.
   c. Neutral start safety switch.

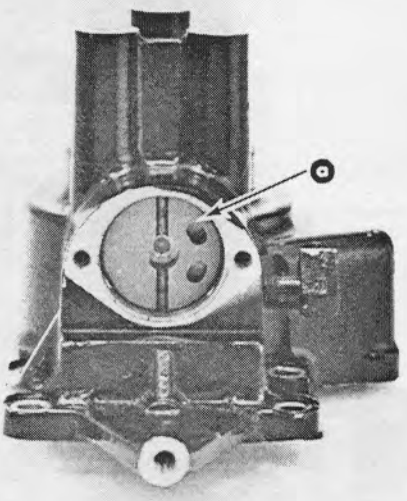


07477

a - Shift Mechanism Screw
b - Cam Follower and Screw
c - Cam
d - Control Valve Cap
e - Screws/Lockwashers (2)

Figure 1. Cam and Follower

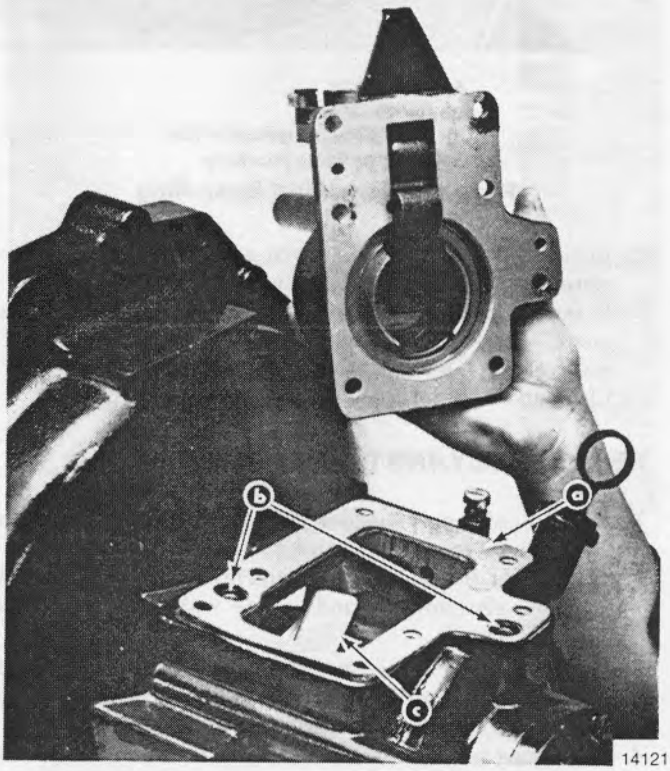
2. Remove shift mechanism attaching screw. (Figure 1)
3. Remove cam follower attaching screw and remove cam follower. (Figure 1)
4. Remove cam and nylon washer from control valve shaft. (Figure 1)
5. Remove 2 screws and lockwashers from control valve cap (Figure 1) and pull cap from housing.
6. Remove control valve shaft assembly from cap and remove washer from shaft. Remove "O" rings from shaft and cap. DO NOT remove roll pin from shaft unless replacement is necessary.
7. Remove control valve disc from housing. (Figure 2)
8. Remove control valve housing screws and lockwashers, then housing. If necessary, tap housing with plastic mallet to loosen. (Figure 3)



14634

a - Control Valve Disc

Figure 2. Control Valve Disc

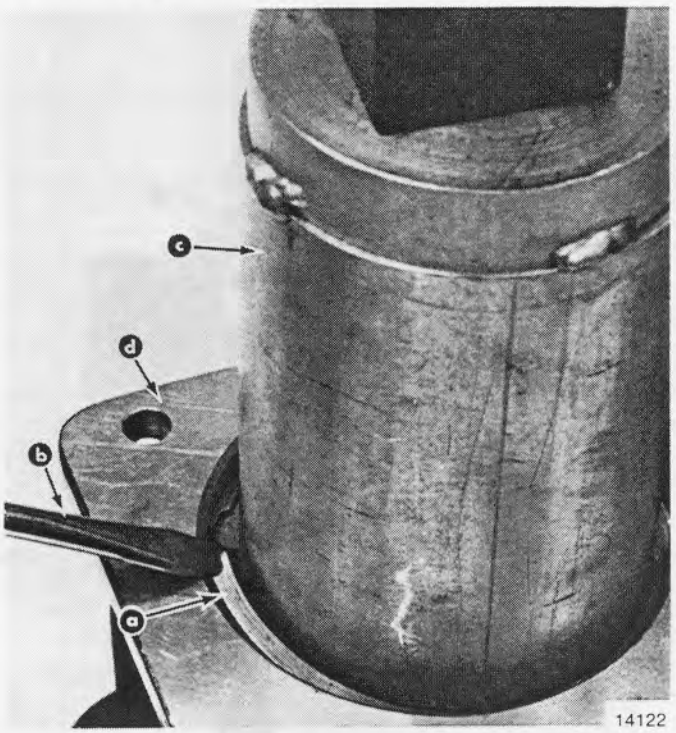


14121

a - Gasket b - "O" Rings (2) c - Reverse Clutch Link

Figure 3. Removing Control Valve Housing

11. Place control valve housing assembly on an arbor press. Compress servo piston spring with Piston Housing Compressor and remove snap ring. (Figure 4)



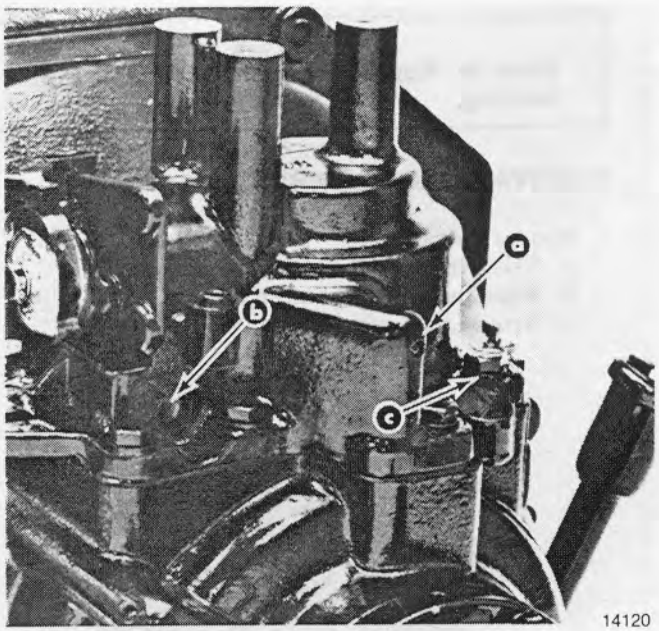
a - Snap Ring
b - Screw Driver
c - 91-65305 Compressor Tool
d - Control Valve Housing

Figure 4. Removing Snap Ring

12. Remove spring retainer, servo piston spring and servo piston from housing. Remove servo piston "O" ring.
13. If reverse clutch lever bushing or pin requires replacement, remove expansion plug from housing and remove reverse clutch lever pin, lever and bushing.
14. Clean and inspect all parts. Replace damaged parts.

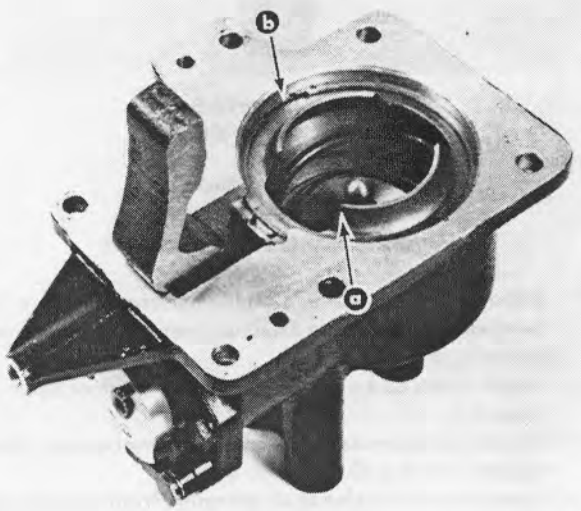
REASSEMBLY/INSTALLATION

1. If removed, apply Loctite 242 Blue to sealing ball and install in oil passage. (Figure 5)
2. If removed, install reverse clutch lever, bushing and pin in control valve housing and secure with a new expansion plug. (Figure 5)
3. Install new "O" ring on servo piston. Install piston into housing with pin facing out. Place spring on servo piston with small diameter end toward piston.
4. Set spring retainer on top of spring as shown in Figure 6.
5. Using Piston Housing Compressor and an arbor press, compress servo piston spring and install snap ring as shown in Figure 6.



a - 1/4" Sealing Ball
b - Expansion Plug
c - Clamp

Figure 5. Sealing Plug and Expansion Plug



a - Retainer - Slots Aligned with Opening
b - Snap Ring Opening

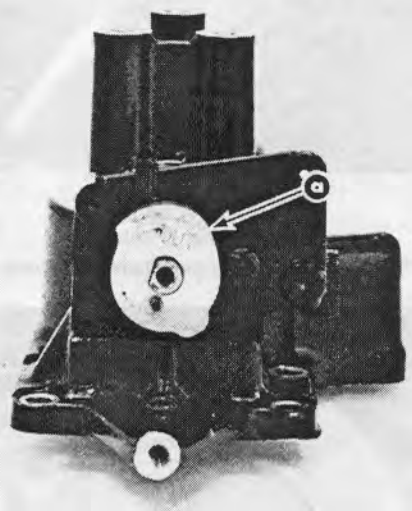
Figure 6. Installing Servo Piston Assembly

6. Install control valve disc in housing, as shown in Figure 2. Straight slot must face outward.
7. If removed, install a new roll pin in control valve shaft, being sure to center it.
8. Install washer and a new "O" ring on control valve shaft and install shaft into control valve cap.
9. Install a new "O" ring on control valve cap. Align flat on control valve shaft with flat in control valve disc and install cap-and-shaft assembly. Secure with 2 screws and lockwashers. Torque screws to specifications.
10. Coat both sides of nylon washer with 2-4-C Multi-Lube and install washer on control valve shaft.

⚠WARNING

Be sure to install cam correctly (in next step) or reverse lock valve and neutral start safety switch will not function properly.

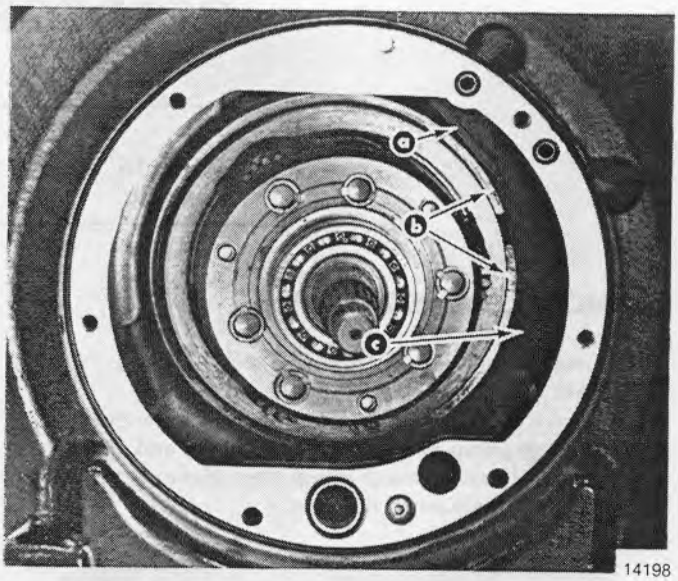
11. Install cam on control valve shaft with side marked "Out" facing outward. (Figure 7) Apply 2-4-C Multi-Lube to cams.



a - Cam (Side Marked "Out" Must Face Outward)

Figure 7. Cam Installed

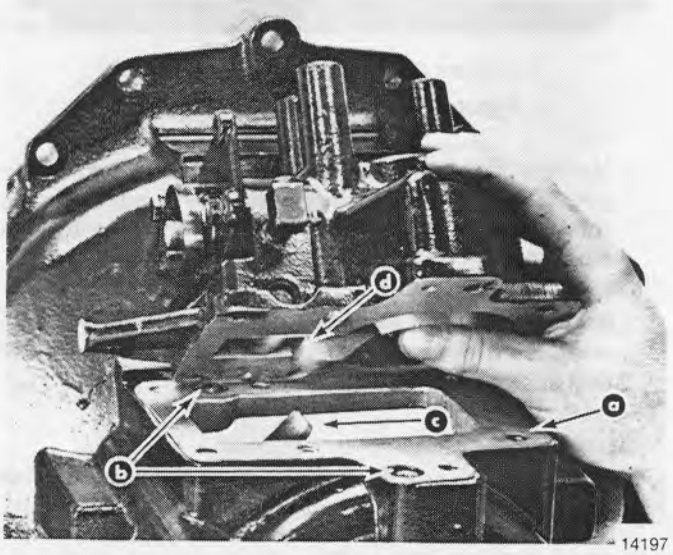
12. Lubricate unthreaded portion of cam follower attaching screw with 2-4-C Multi-Lube. Apply Loctite "A" to threads on cam follower attaching screw and install cam follower. Torque screw to specifications.
13. Place reverse clutch link, on reverse band (so that notch in link aligns with tang on band). (Figure 8)
14. Install 2 new "O" rings and gasket on control valve mating surface on transmission housing. (Figure 9)
15. Hold reverse clutch lever up into control valve housing and slide control valve housing onto transmission so that reverse clutch link mates with notch in reverse clutch lever. (Figure 9)



a - Reverse Clutch Link
b - Reverse Band
c - Reverse Band Anchor Strat

Figure 8. Reverse Clutch

16. Secure control valve to transmission with screws and lockwashers. Install "J" clamp at location shown in Figure 5. Torque screws to specifications.
17. Install neutral start safety switch.
18. Install reverse lock valve.
19. Install shift mechanism.
20. **Electric Shift Models:** Install shift actuator.
    Mechanical Shift Models: Install shift linkage.
21. Adjust reverse clutch band, as outlined.



a - Gasket
b - "O" Rings
c - Reverse Clutch Link
d - Notch in Reverse Clutch Lever

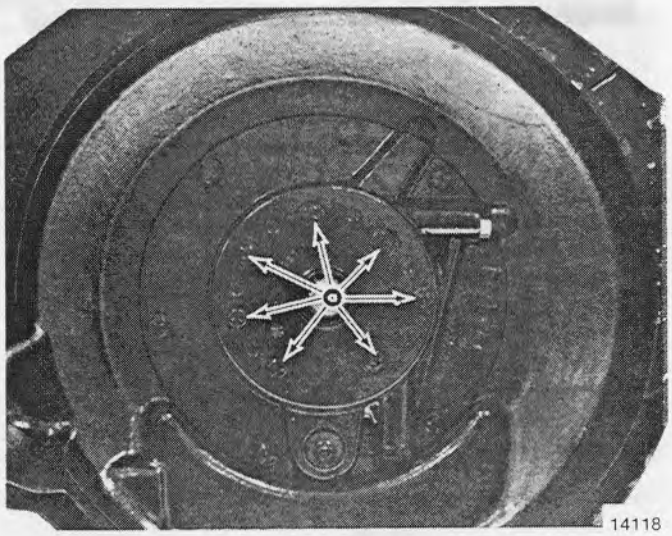
Figure 9. Installing Control Valve Housing

GEROTOR PUMP REPAIR

NOTICE
Refer to "Repair Precautions" BEFORE proceeding.

REMOVAL/DISASSEMBLY

1. Remove transmission from engine as outlined.
2. Place transmission in a suitable stand.
3. Drain transmission fluid as outlined in "Changing Fluid".
4. Remove pump cover attaching screws and lockwashers (Figure 1) and remove pump over. Remove pump cover "O" ring from pump housing.



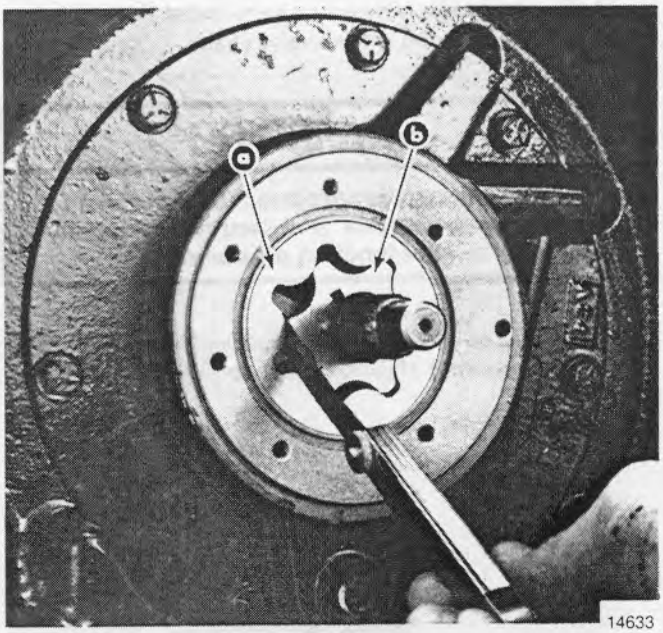
a - Pump Cover Screws/Lockwashers (7)

Figure 1. Removing Pump Cover

5. Measure clearance between pump gerotor with feeler gauge. (Figure 2) Clearance between inner and outer elements should be .007" - .013" (.2 - .3mm). If not within limits, pump gerotor must be replaced.

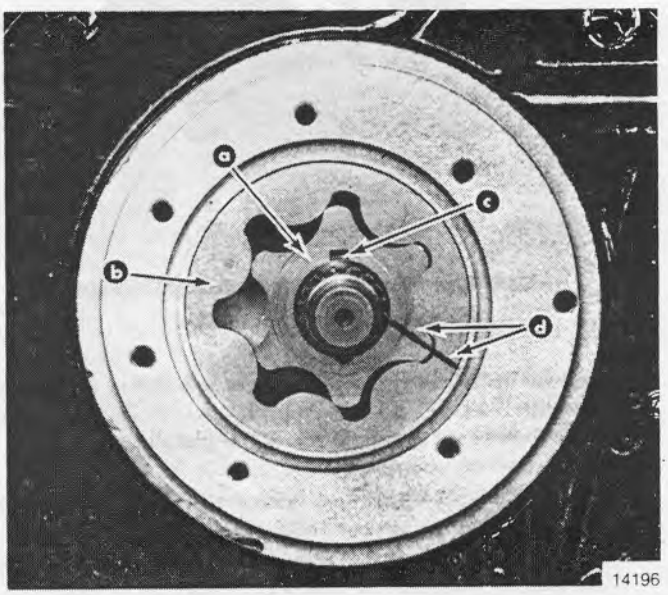
IMPORTANT: Pump gerotor elements MUST BE installed with same side indexed or reduced output and possible failure may occur.

6. Using a grease pencil, mark the inner and outer gerotor elements to assure proper installation later. (Figure 3).
7. Remove inner gerotor, then remove outer gerotor.
8. Remove Woodruff key (Figure 3) from input shaft.
9. Remove pump housing attaching screws and sealing washers. Install "T" Handles in pump housing, and pull pump housing straight out. (Figure 4) Remove 4 "O" rings from transmission housing.



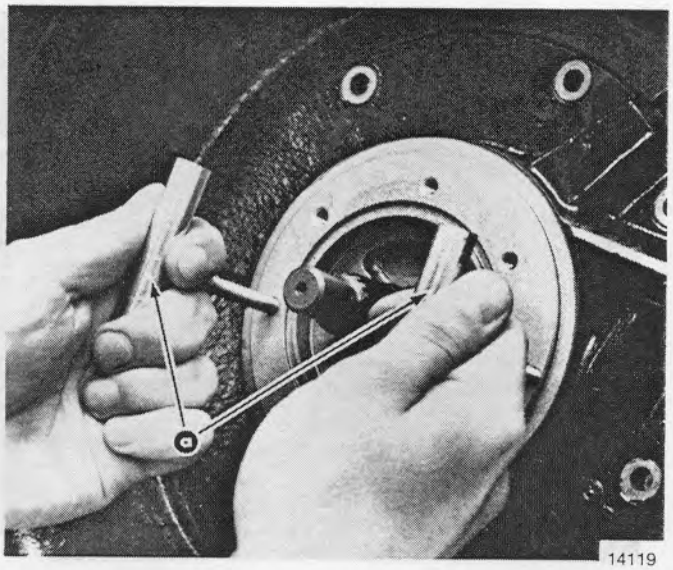
a - Outer Gerotor
b - Inner Gerotor

Figure 2. Measuring Gerotor Clearance



a - Inner Gerotor
b - Outer Gerotor
c - Woodruff Key
d - Grease Pencil Marking

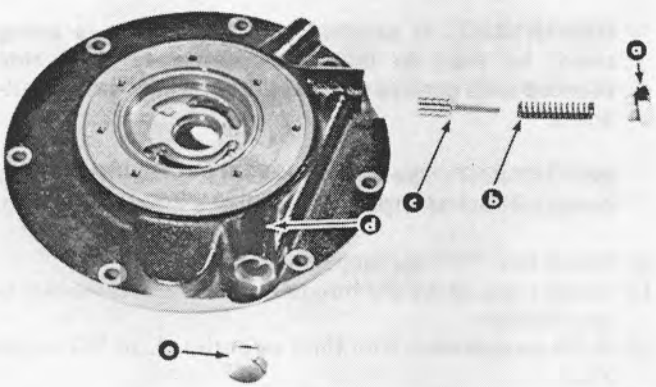
Figure 3. Gerotor Pump



a - 91-65301 "T" Handles

Figure 4. Removing Pump Housing

10. Remove relief valve plug, spring and relief valve from pump housing. Remove "O" ring from plug. (Figure 5)
11. Remove plug from pump housing discharge passage. Remove "O" ring. (Figure 5)



a - Relief Valve Plug and "O" Ring
b - Spring
c - Relief Valve
d - Discharge Passage
e - Plug and "O" Ring

Figure 5. Pump Housing

12. If neccessary, remove other pipe plugs from housing to allow a thorough cleaning of passages.
13. Remove oil seal from cover.

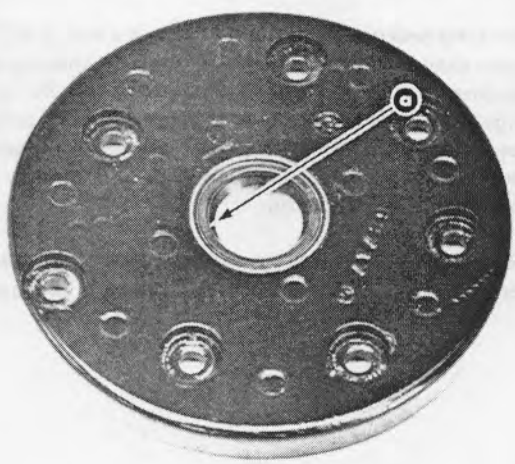
CLEANING and INSPECTION

1. Clean all parts in solvent and blow dry with compressed air.
2. Inspect pump gerotor inner and outer elements and contact surface on pump housing and cover for wear, scoring or other damage. Minor scratches on cover and housing are permissible, however, if condition is questionable, components should be replaced.
3. Inspect relief valve piston for scoring and for freedom of movement in bore.
4. Inspect relief valve spring for distortion and inadequate tension.
5. Inspect pump housing to transmission housing mating surfaces and pump cover to housing mating surfaces for nicks or scratches. Surfaces must be perfectly smooth or fluid leakage may result.

REASSEMBLY/INSTALLATION

IMPORTANT: DO NOT allow Loctite to get on seal lip when installing seal.

1. Apply Loctite "A" to outer diameter of a new oil seal and install as shown in Figure 6. Press seal in until it is flush with cover. (Figure 6)
2. If removed, apply Loctite 242 Blue to threads of 2 pipe plugs and install in pump housing. Torque plugs to specifications.
3. Lubricate relief valve with ATF and install piston and spring in pump housing bore. Install relief valve plug (with a new "O" ring) and torqe to specifications.



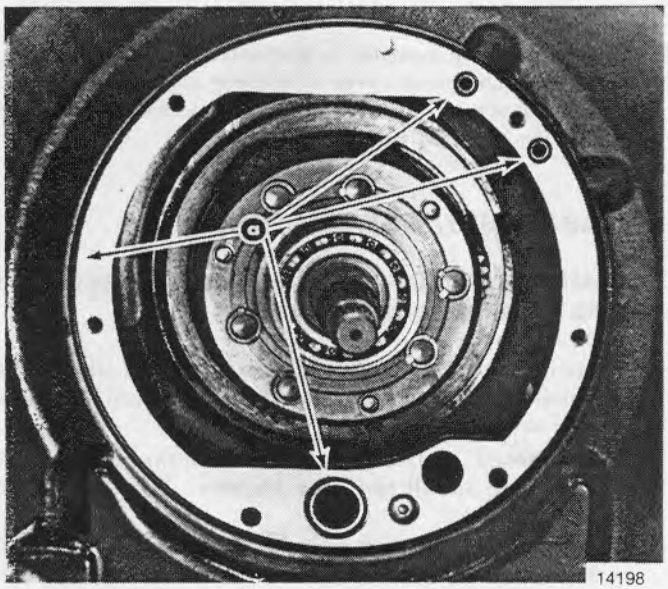
a - Oil Seal Lip Toward Gerotor Side of Cover

Figure 6. Pump Cover

4. Install a new "O" ring on other plug and install plug in discharge passage. Torque plug to specifications.

IMPORTANT: Check inside of transmission to make sure reverse clutch band and linkage is positioned properly.

5. Install 4 new "O" rings on pump housing mating surface on transmission housing. (Figure 7)

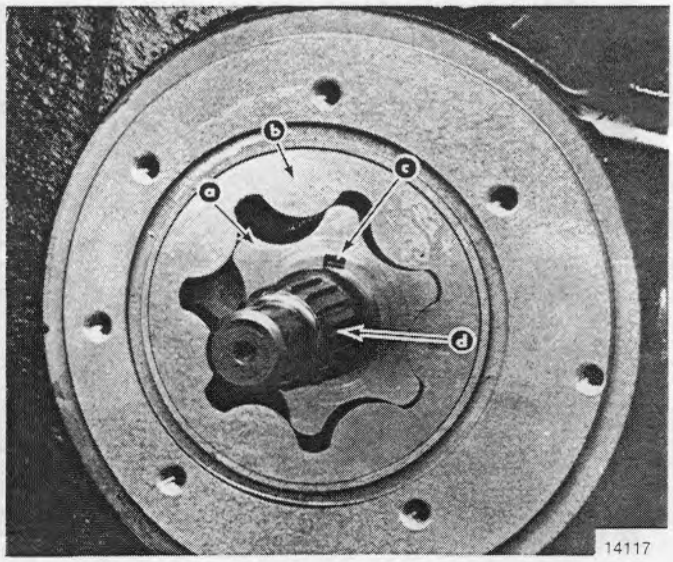


a - "O" Rings

Figure 7. Transmission Housing

6. Lubricate bearing bore in pump housing with 2-4-C Multi-Lube, then install "T" Handles in pump housing and set housing into place in transmission. (Figure 4) Be sure "O" rings do not fall out of grooves. Remove "T" handles.
7. Apply Loctite 242 Blue to threads on pump housing screws and install screws and new sealing washers. Torque screws EVENLY to specifications.

IMPORTANT: Two longer pump housing attaching screws are installed in bottom 2 holes in housing.



a - Inner Gerotor
b - Outer Gerotor
c - Key (Install With Flat Side Down)
d - Input Shaft

Figure 8. Pump Gerotor Installed

8. Place key in input shaft with flat side of key down.
9. Lubricate pump gerotor inner and outer elements with ATF.
10. Align keyway in gerotor inner element with key on input shaft and install inner and outer elements. (Figure 8)

IMPORTANT: If original pump gerotor is being used, be sure to install elements so that side marked with grease pencil (during removal) is outward.

IMPORTANT: Use care to prevent damaging pump cover oil seal on input shaft splines when installing.

11. Install new "O" ring on pump housing.
12. Install pump cover and torque screws and lockwashers to specifications.
13. Refill transmission with fluid as outlined. in "Changing Fluid".
14. Reinstall transmission to engine as outlined.

PLANETARY ASSEMBLY REPAIR

NOTICE
Refer to "Repair Precautions" BEFORE proceeding.

REMOVAL/DISASSEMBLY

1. Remove the following (as outlined).
   a. Fluid cooler.
   b. Output housing.
   c. Control valve housing.
   d. Gerotor pump.
2. Remove snap ring from output shaft. (Figure 1)

IMPORTANT: DO NOT drag snap ring on output shaft sealing surface.

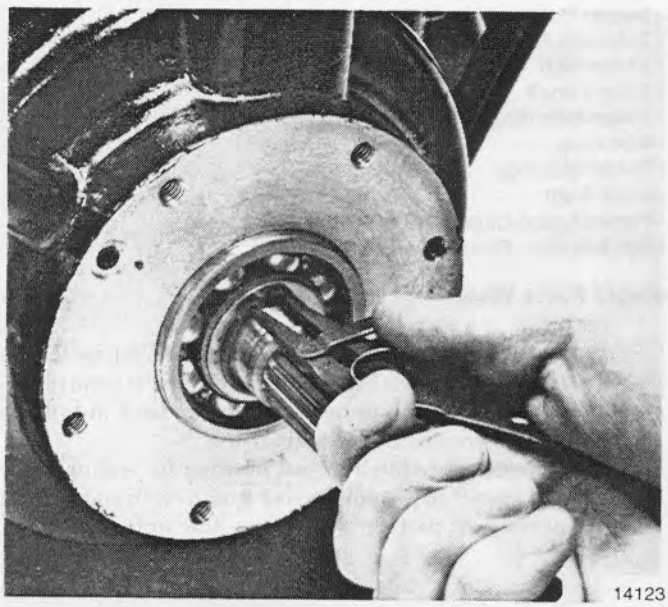
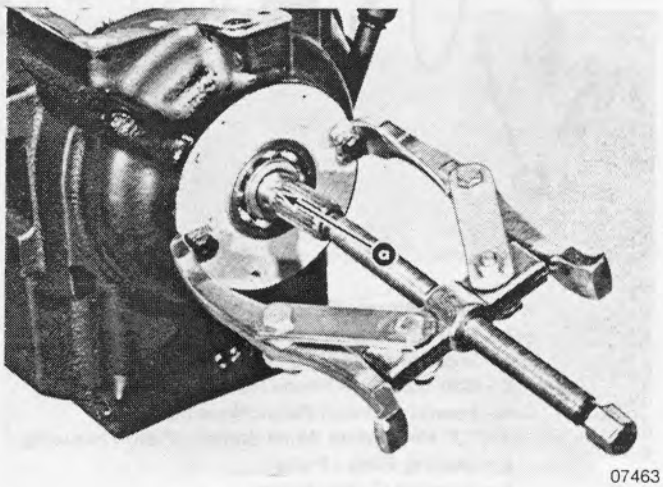


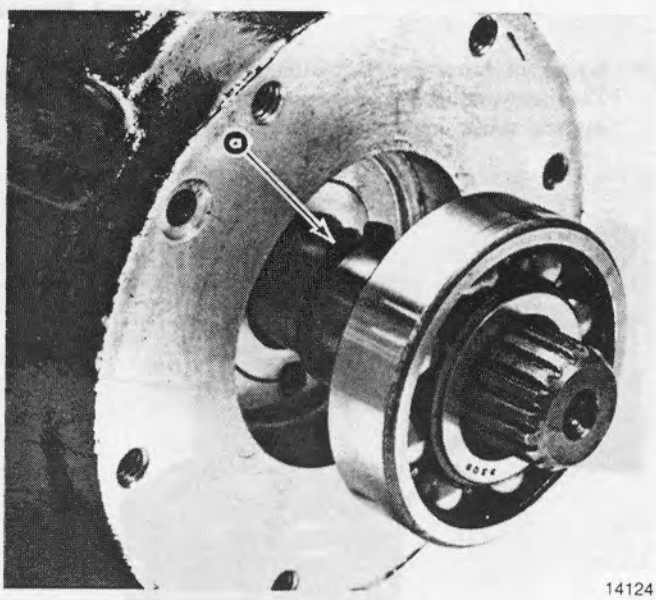
Figure 1. Removing Outer Snap Ring

3. Using a suitable tool, press output shaft inward until solid resistance is felt. This indicates that inner snap ring has dropped into outer snap ring groove. (Figure 2)
4. Push planetary assembly (on input shaft end) inward to force output bearing from housing and remove bearing. (Figure 3) Remove inner snap ring.
5. Remove planetary assembly from housing.



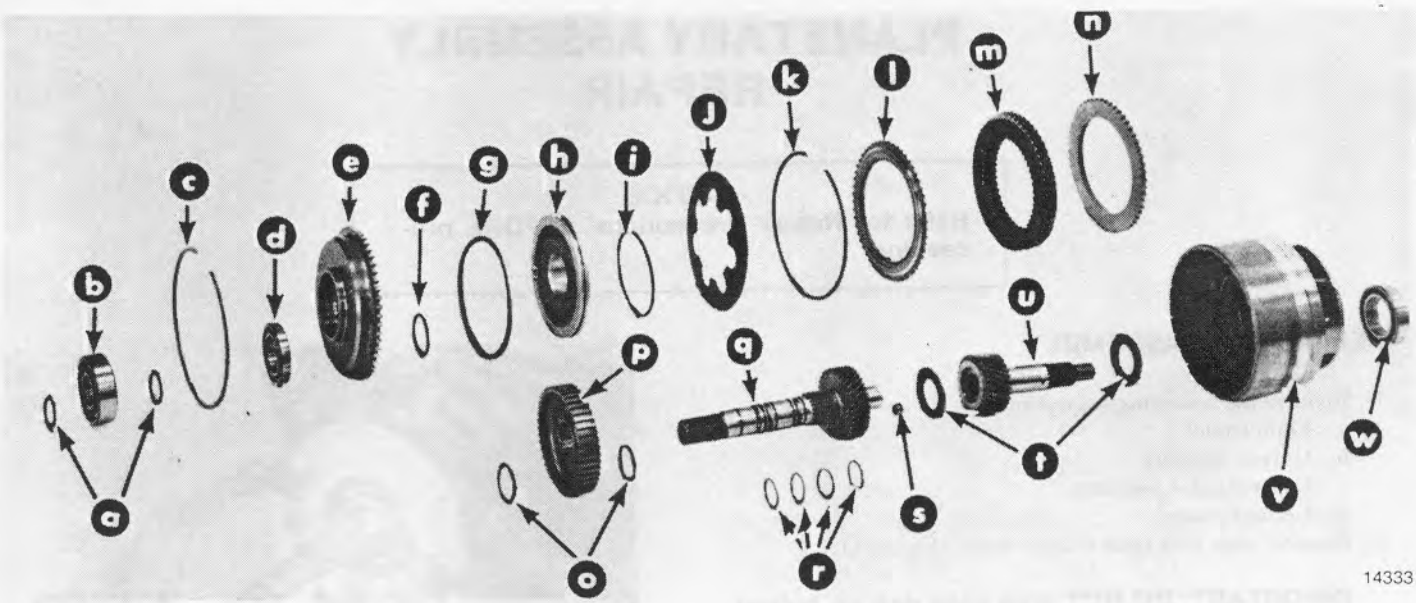
a - Press Inward on Output Shaft

Figure 2. Pressing Inner Snap Ring into Outer Snap Ring Groove



a - Inner Snap Ring

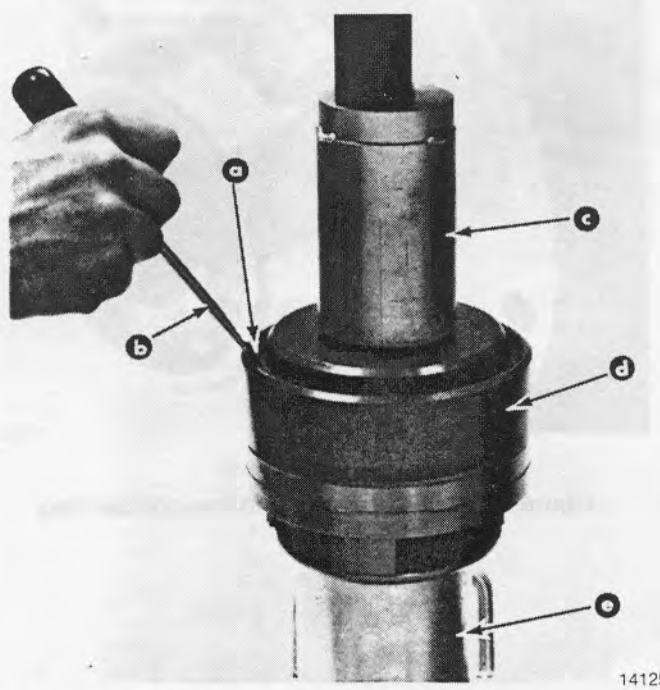
Figure 3. Output Bearing and Inner Snap Ring Removal



a - Snap Rings - Output Shaft
b - Ball Bearing - Output Shaft
c - Internal Snap Ring - Clutch Drum
d - Ball Bearing - Piston Housing
e - Forward Clutch Piston Housing
f - "O" Ring (With White Stripe) - Piston Housing
g - Sealing Ring - Piston
h - Forward Clutch Piston
i - Spring Pressure Ring
j - Clutch Pressure Spring
k - Internal Snap Ring - Pressure Plate
l - Pressure Plate
m - Clutch Plates - 5 Fiber Faced Plates and 4 Steel Plates.
n - Spacer Plate
o - Retaining Rings - Clutch Hub
p - Clutch Hub
q - Output Shaft
r - Teflon Seal Rings - Output Shaft
s - Pipe Plug
t - Thrust Bearings
u - Input Shaft
v - Planetary and Clutch Drum Assembly
w - Ball Bearing - Planetary and Clutch Drum

Figure 4. Planetary Assembly Parts View

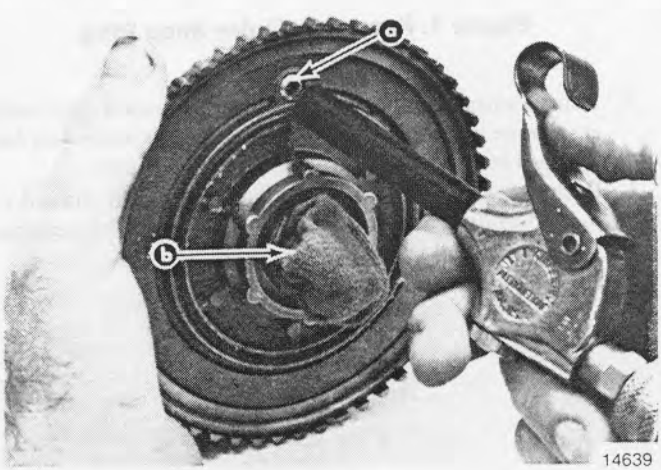
6. Using an arbor press, Piston Housing Compressor and Planetary Holding Fixture, compress clutch piston housing and remove internal snap ring. (Figure 5)



a - Internal Snap Ring
b - Screwdriver
c - 91-65305 Piston Housing Compressor
d - Planetary and Clutch Drum Assembly
e - 91-65307 Planetary Holding Fixture

Figure 5. Internal Snap Ring Removal

7. Tap lightly on input shaft with a soft mallet to loosen forward clutch piston housing; then remove it from planetary assembly. Place planetary assembly back in holding fixture after removing piston housing.
8. Remove forward clutch piston housing by sealing three holes in center of piston housing with a cloth and forcing compressed air past check ball into hole in top of piston. (Figure 6)



a - Check Ball
b - Cloth

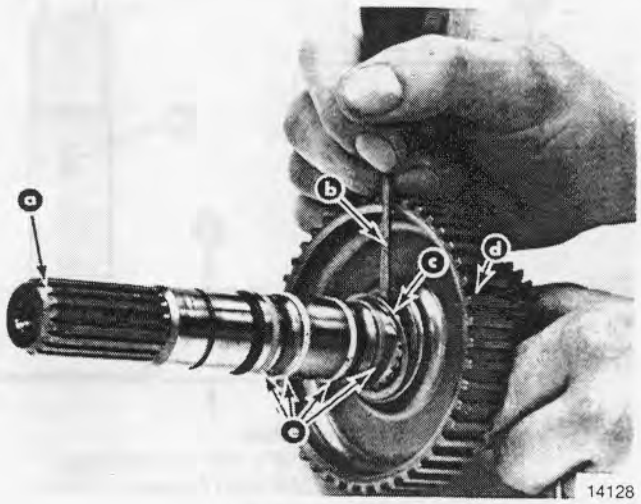
Figure 6. Removing Forward Clutch Piston

9. Remove sealing ring from forward clutch piston and "O" ring from piston housing. If pressure ring on piston is worn or damaged, remove and discard ring.
10. Remove pressure spring from planetary.
11. Remove output shaft and rear thrust bearing.

IMPORTANT: DO NOT drag retaining (or snap) rings across output shaft sealing surface. Sealing surface MUST BE free of scratches, nicks etc., or oil leakage and subsequents loss of pressure may occur.

12. Remove retaining ring from output shaft with screwdriver and remove clutch hub. (Figure 7) Remove second retaining ring in same manner. On models equipped with snap rings on output shaft, remove snap rings with snap ring pliers.

IMPORTANT: If clutch hub was secured with snap rings, replace snap rings with spiral retaining rings (contained in transmission repair kit) when reassembling.



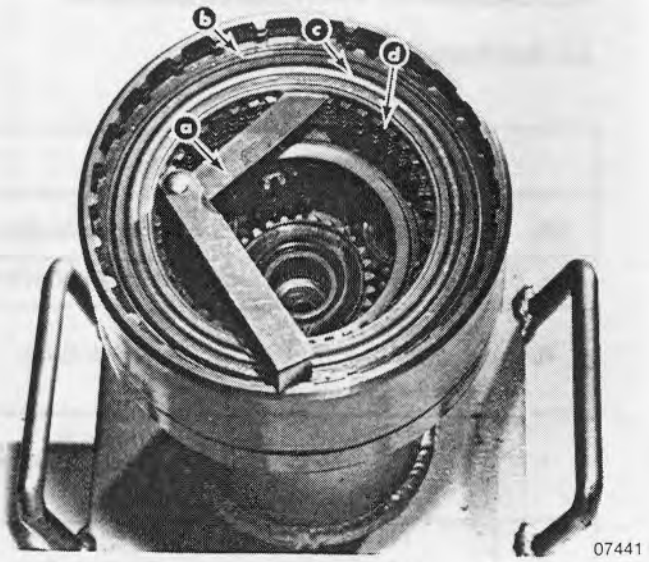
a - Output Shaft
b - Screwdriver
c - Retaining Ring
d - Clutch Hub
e - Teflon Seal Rings

Figure 7. Removing Retaining Ring From Output Shaft

13. Remove teflon seal rings (Figure 7) from output shaft. Use care not to scratch or mar output shaft sealing surface.

IMPORTANT: Replace teflon seal rings in a set only.

14. Lift pressure plate until it contacts internal snap ring, then measure clearance between pressure plate and clutch pack. (Figure 8) Clearance must be .020" - .050" (.5 - 1mm). If clearance is not within specifications, clutch plates are worn and a new clutch plate kit must be installed.
15. Remove internal snap ring, pressure plate, clutch pack and clutch pack spacer plate from planetary.
16. Remove input shaft and front thrust bearing.



a - Feeler Gauge
b - Internal Snap Ring
c - Pressure Plate
d - Clutch Pack (Plates)

Figure 8. Measuring Clutch Pack Clearance

CLEANING and INSPECTION

1. Clean all parts and blow dry with compressed air.
2. Inspect ball bearings.
3. Inspect thrust bearings.
4. Inspect input shaft needle bearings.
5. Inspect input shaft bushing (in planetary and drum assembly) and bushing surface on input shaft.

IMPORTANT: Shallow scratches or grooves in input shaft bushing or on input shaft bushing surface are acceptable and DO NOT necessitate component replacement. If condition of parts are questionable, however, components should be replaced.

6. Inspect planetary gears and gears on input and output shafts.
7. Inspect splines in clutch hub and on input and output shafts.
8. Inspect output shaft sealing surface (on shaft and in transmission housing) to ensure that it is free of any nicks or scratches.
9. Inspect clutch plates for visible wear, warpage or embedded material. Clutch plates must be replaced if damaged.
10. Inspect snap rings and snap ring grooves.
11. Inspect planetary gears for excessive side or end play. Excessive end play is indicated when flat surface on ends of needle bearings can be seen. This condition will result if the thin washer between gear nd planetary housing is badly scored or has disintegrated.
12. Inspect check ball in forward clutch piston to assure freedom of movement and proper sealing.
13. Inspect sealing surfaces in forward clutch piston and housing for grooves, scratches or burrs which would prevent them from sealing properly.
14. Inspect pressure ring.

REPLACEMENT PART INFORMATION

Clutch Pack Kit (62691A1)

IDENTIFICATION		
Qty.	**Plate Type**	**Identification**
4	Steel Plates	External Splines
5	Fiber Plates .056" - .060" (1.422 - 1.524mm)	No Strip
1	Fiber Plate .070" - .075" (1.778 - 1.905mm)	1 White Strip
1	Fiber Plate .084" - .089" (2.133 - 2.260mm)	2 White Strips

Input Shaft (77448A1)

When installing input shaft 77448A1 in transmissions equipped with output shaft 62754, the output shaft MUST also be replaced with output shaft 67993A2. Input shaft 77448A1 CANNOT be installed with output shaft 62754. Refer to Figure 8A for output shaft identification.

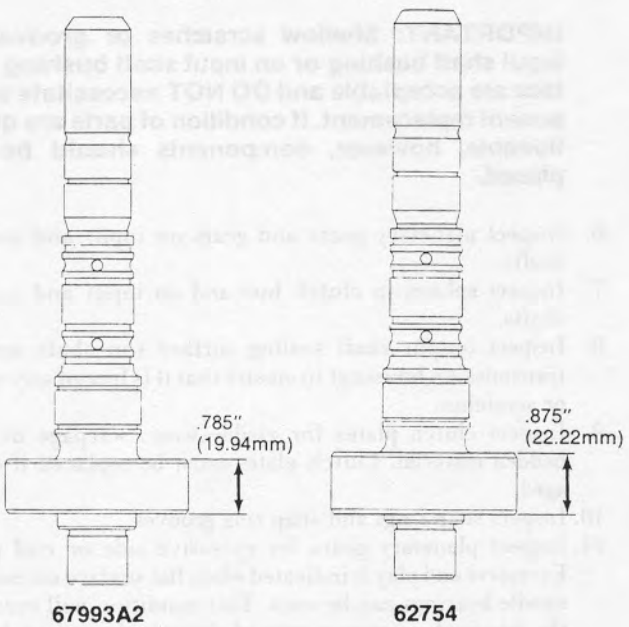
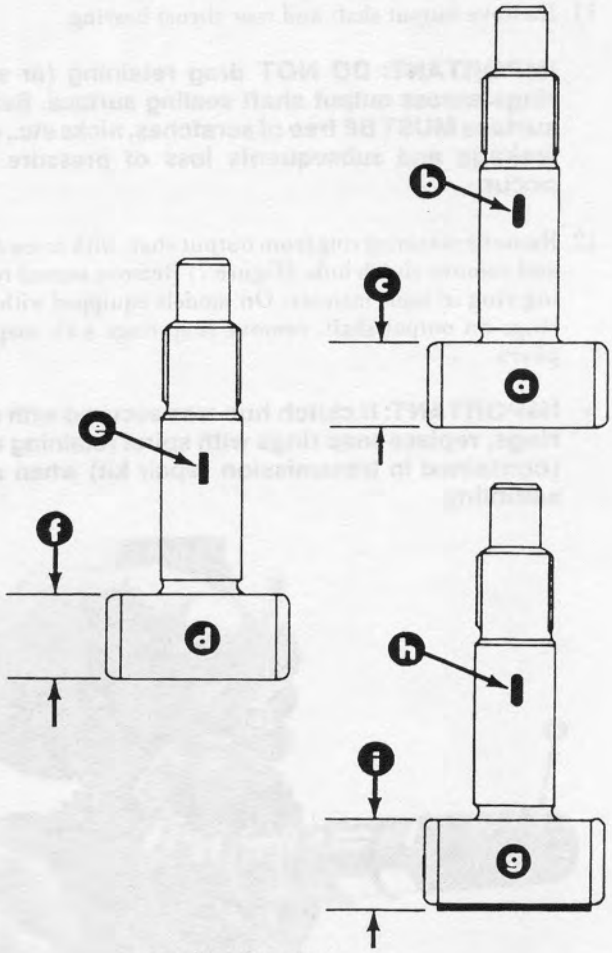


Figure 8A. Output Shaft

Output Shaft (67993A2)

1. Use Figure 8B to determine part number of input shaft.



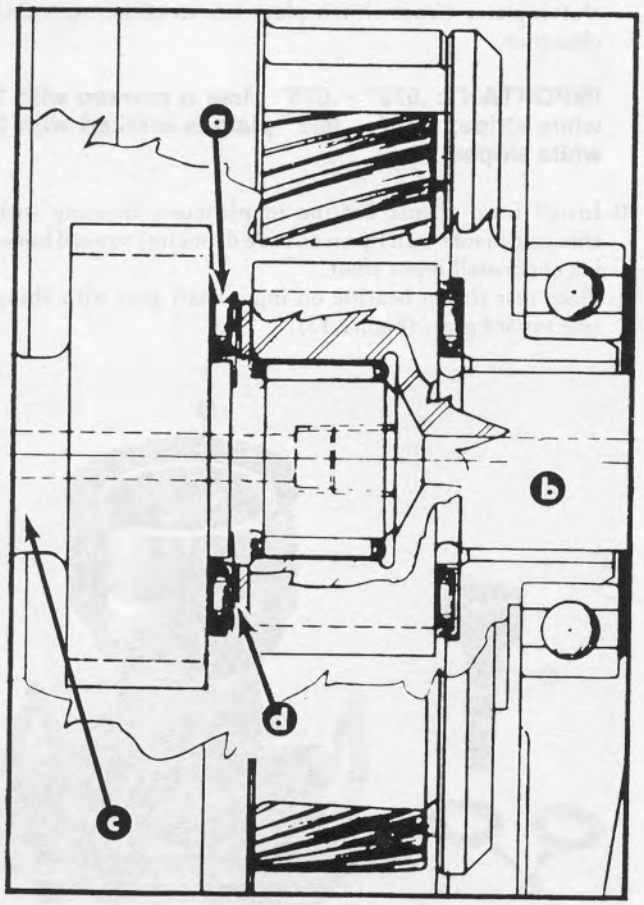
a - 76187 Input Shaft
b - Keyway - 3/16" [.187" (4.7498mm)]
c - 1-3/64" [1.054" (26.7716mm)]
d - 62736 Input Shaft
e - Keyway - 1/8" [.125 (3.175mm)]
f - 1-3/64" [1.054" (26.7716mm)]
g - 77448 Input Shaft
h - Keyway - 3/16" [.187" (4.7498mm)]
i - 1-9/64 [1.144" (29.0576mm)]

Figure 8B. Input Shaft Identification

2. When installing output shaft 67993A2 in a transmission equipped with input shafts 62736 or 76187A1, spacer washer 23-67991 (supplied with output shaft) must be used. Install spacer washer between the interior end of input shaft and thrust bearing, as shown in Figure 8C.
3. When installing output shaft 67993A2 in a transmission equipped with input shaft 77448, spacer washer should not be used.

⚠CAUTION

If spacer 23-67991 is used with input shaft 77448, transmission failure will occur.



a - Thrust Bearing
b - Input Shaft (62736 or 76187A1)
c - Output Shaft (67993A2)
d - Spacer (23-67991)

Figure 8C. Spacer Location

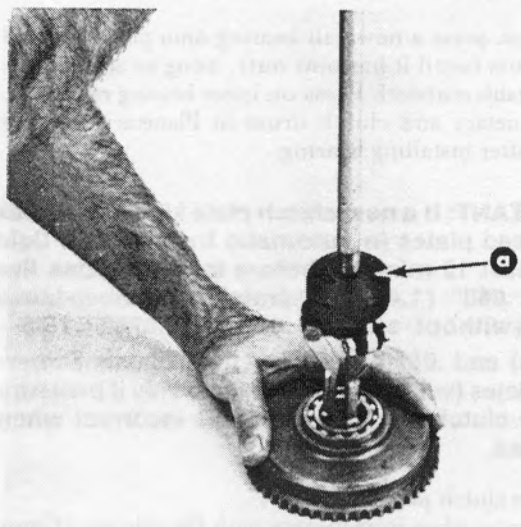
REASSEMBLY/INSTALLATION

1. If inspection reveals that piston housing ball bearing or planetary and clutch drum ball bearing requires replacement, remove bearings, using Slide Hammer Puller. (Figures 10 and 11)

IMPORTANT: Puller jaws must be modified, as shown in Figure 9, to allow removal of bearings. DO NOT use modified puller jaws for other application which require excessive force as puller jaw tips may be damaged. New replacement jaws for puller can be obtained by ordering Part No. 91-34570, (order 3).

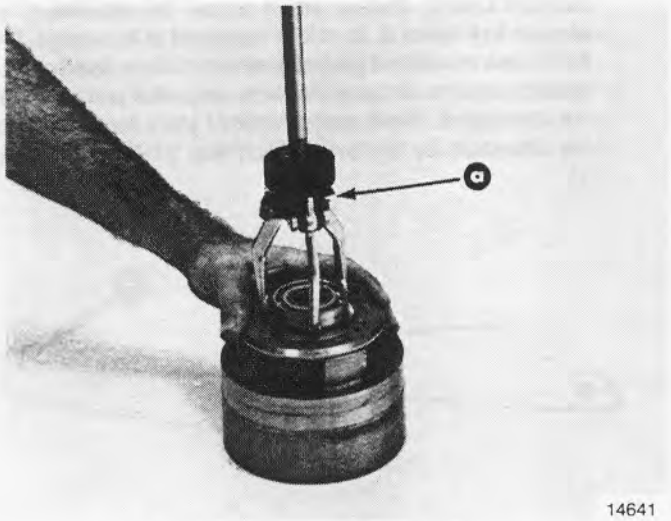
a - Grind Until Fingers Fit Into Opening

Figure 9. Modifying Puller Jaws



a - 91-34569A1 Slide Hammer Puller

Figure 10. Removing Ball Bearing From Piston Housing



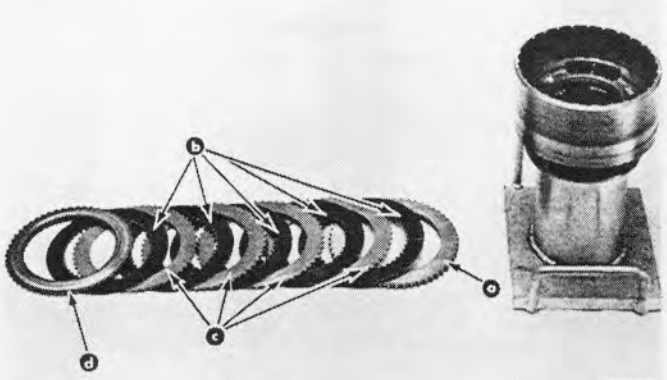
a - 91-34569A1 Slide Hammer Puller

Figure 11. Removing Ball Bearing From Planetary and Clutch Drum

2. If removed, press a new ball bearing onto planetary and clutch drum (until it bottoms out), using an arbor press and a suitable mandrel. Press on inner bearing race only.
3. Place planetary and clutch drum in Planetary Holding Fixture, after installing bearing.

IMPORTANT: If a new clutch plate kit is used, soak fiber-faced plates in automatic transmission fluid for at least 15 minutes before installing. Use five .056" - .060" (1.42 - 1.52mm) thick fiber-faced plates (without stripes). .070" - .075" (1.78 - 1.91mm) and .084" - .089" (2.14 - 2.26mm) fiber-faced plates (with stripes) are used only if pressure plate to clutch pack clearance is incorrect when measured.

4. Lubricate clutch plates with ATF.
5. Install spacer plate in planetary with flat side up. (Figure 12)
6. Install 5 fiber-faced clutch plates and 4 steel clutch plates, starting with a fiber-faced plate and alternating steel and fiber-faced plates thereafter. (Figure 12)
7. Install pressure plate with flat side down. (Figure 12)
8. Install internal snap ring in second groove from top of planetary.



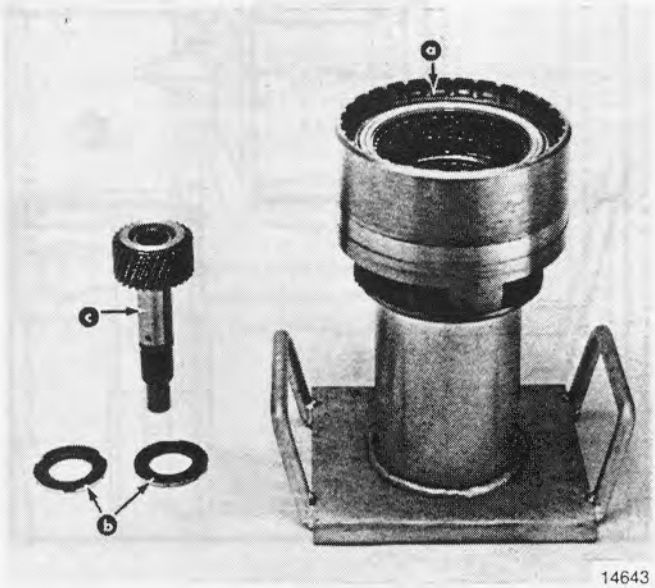
a - Spacer Plate (Install with Flat Side Up)
b - Fiber-Faced Clutch Plates
c - Steel Clutch Plates
d - Pressure Plate (Install with Flat Side Down)

Figure 12. Forward Clutch Plates Installation

9. Lift pressure plate until it contacts snap ring and measure clearance between pressure plate and clutch pack. (Figure 8) Clearance MUST BE .020" - .050" (.5 - 1mm). If clearance is excessive, replace 1 or 2 of the .056" - .060" (1.42 -1.52mm) fiber-faced clutch plates with .070" - .075" (1.78 -1.91mm) and/or .084" - .089" (2.14 - 2.26mm) fiber-faced clutch plates (from clutch plate kit) to obtain specified clearance.

IMPORTANT: .070" - .075" plate is marked with 1 white stripe; .084" - .089" plate is marked with 2 white stripes.

10. Install front thrust bearing in planetary housing with shiny side (side with lip on outside diameter) toward housing and install input shaft.
11. Place rear thrust bearing on input shaft gear with shiny side toward gear. (Figure 13)



a - Planetary and Clutch Drum
b - Thrust Bearings (Install With Shiny Side Downward)
c - Input Shaft

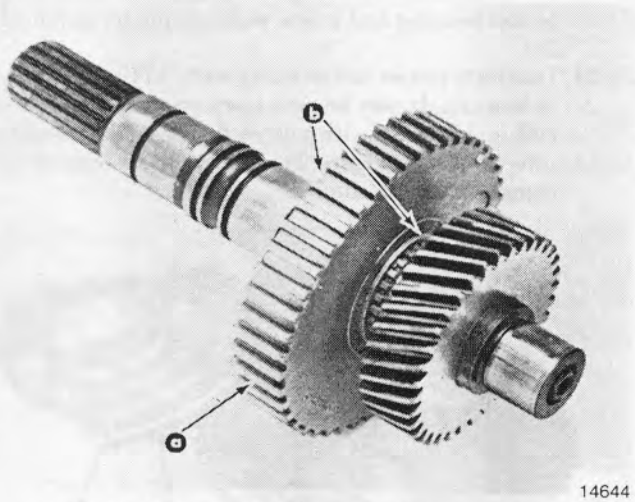
Figure 13. Thrust Bearings and Input Shaft Installation

IMPORTANT: Replacement output shaft does not have brass plug installed.

12. If removed, coat threads of pipe plug with Loctite 242 Blue and install in end of output shaft. Torque pipe plug to specifications. After torquing, check to ensure that plug is flush with end of shaft.

IMPORTANT: If clutch hub was originally secured to output shaft with snap rings, replace snap rings with spiral retaining rings (contained in transmission repair kit), in next step.

13. Install retaining ring into second groove on output shaft. Install clutch hub on output shaft with flat side of hub toward output shaft gear. Install remaining retaining ring on shaft. (Figure 14)

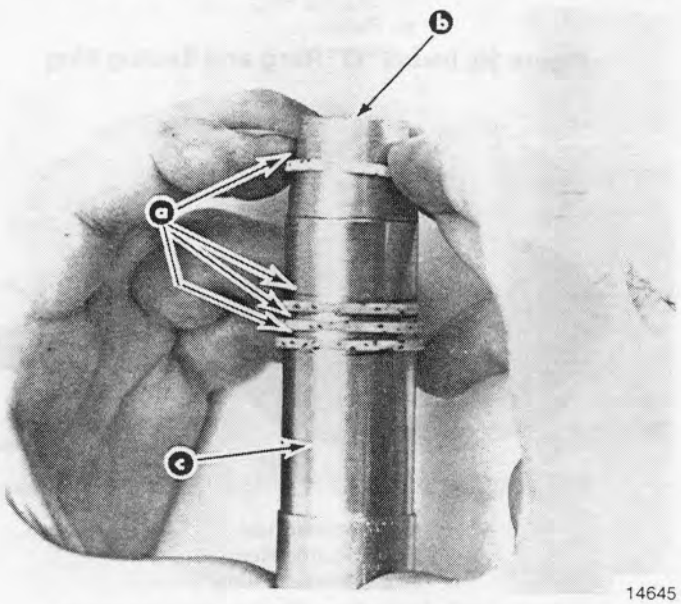


14644

a - Clutch Hub (Install With Flat Side Toward Gear)
b - Spiral Retaining Rings (1 Hidden)

Figure 14. Clutch Hub Installation

14. Install teflon seal rings onto Seal Ring Installing Tool, using Taper Plug. (Figure 15) Lubricate rings with ATF.



14645

a - Teflon Seal Rings
b - 91-65304 Taper Plug
c - 91-65303 Seal Ring Installing Tool

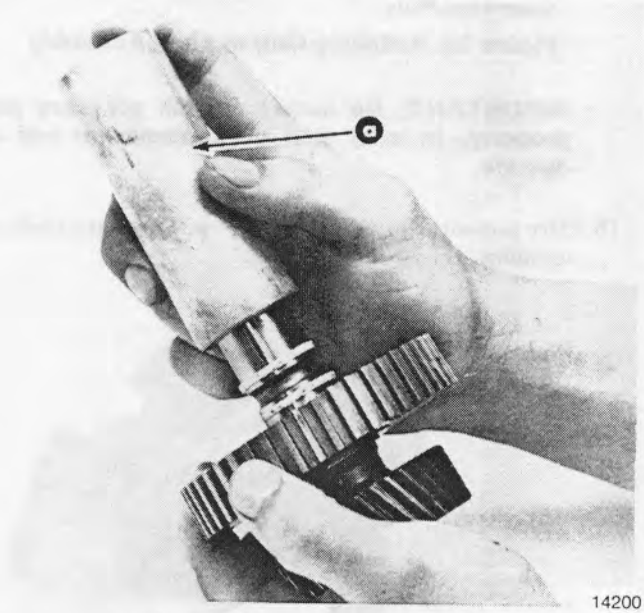
Figure 15. Teflon Seal Rings Installed on Seal Ring Installing Tool

15. Remove Taper Plug from Seal Ring Installing Tool, then slide Installing Tool over output shaft. Push teflon seal rings from tool and into grooves in output shaft. (Figure 16)
16. Compress teflon seal rings in grooves with fingers, then install Seal Ring Compressor Tool over shaft and seal rings. (Figure 17) Leave tool in position a few minutes to fully seat seal rings.

14646

a - 91-65303 Seal Ring Installing Tool

Figure 16. Installing Teflon Seal Rings into Grooves in Output Shaft



14200

a - 91-65302 Seal Ring Compressor Tool

Figure 17. Compressing Teflon Seal Rings

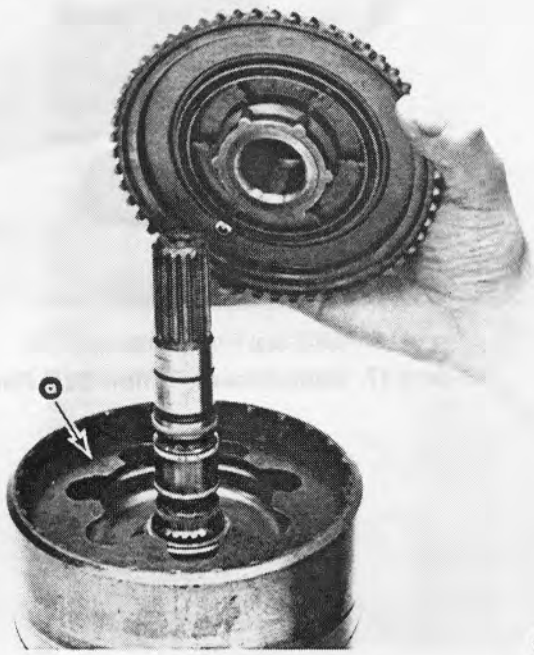
17. Make sure that thrust bearing is still in place on input shaft gear, then install output shaft assembly in planetary by rotating it to align splines on fiber-faced clutch plates with splines on clutch hub. Shaft is properly installed when clutch hub is flush with outer-most fiber-faced clutch plate. (Figure 18)

a - Rotate Shaft to Align Clutch Plate Splines with Clutch Hub Splines
b - Shaft is Properly Installed When Clutch Hub is Flush With Outer-Most Plate

Figure 18. Installing Output Shaft Assembly

IMPORTANT: Be sure to install pressure plate properly, in next step or transmission will not operate.

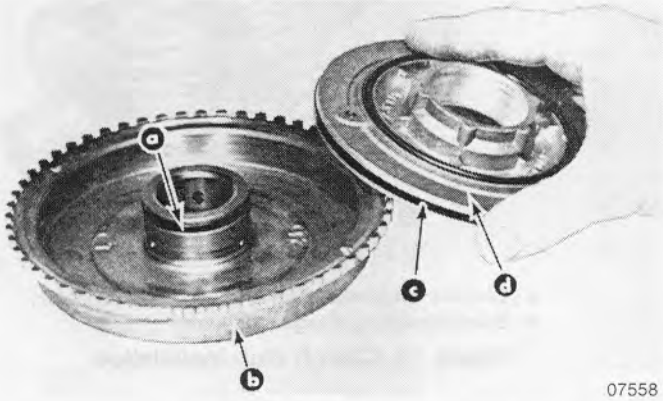
18. Place pressure spring in planetary with concave (hollow) side down. (Figure 19)



a - Pressure Spring - Install with Concave (Hollow) Side Down

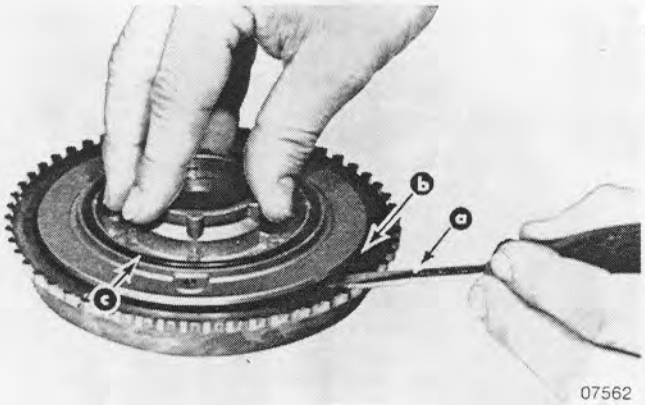
Figure 19. Pressure Spring Installed

19. If bearing was removed from forward clutch piston housing, lubricate bearing bore with 2-4-C Multi-Lube and press a new bearing into housing (until it bottoms-out) using a suitable mandrel. Press on outer bearing race only.
20. Install a new "O" ring (marked with white stripe) in piston housing and a new sealing ring on piston. (Figure 20)
21. Lubricate piston and housing with ATF and install piston in housing. It may be necessary to carefully work sealing ring into housing with a screwdriver while pressing piston into housing. (Figure 21) Use extreme care to prevent damaging sealing ring.



a - "O" Ring
b - Piston Housing
c - Sealing Ring
d - Piston

Figure 20. Install "O" Ring and Sealing Ring



a - Screwdriver
b - Sealing Ring
c - Pressure Ring

Figure 21. Installing Piston Into Housing

22. If removed, treat pressure ring (Figure 21) and groove in piston with Loctite Primer "N". Coat groove in piston with Loctite 242 Blue and install ring. Apply pressure to ring with suitable clamps and allow it to set for 1 hour.

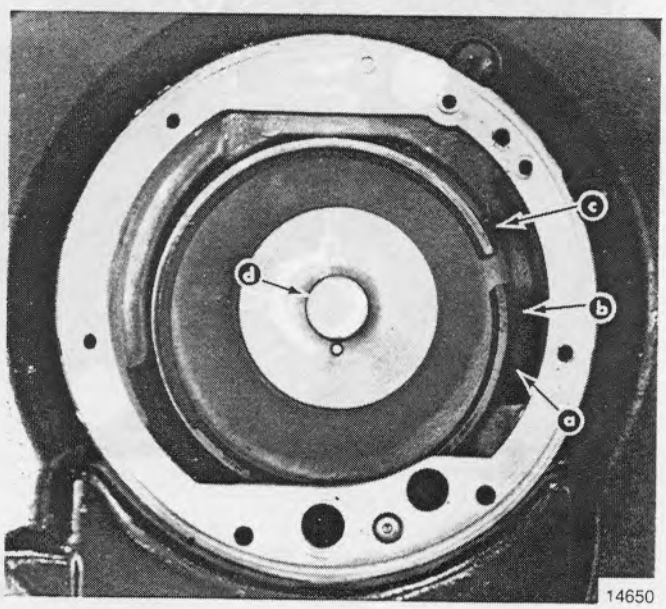
IMPORTANT: Be careful not to damage teflon seal rings on output shaft, in next step.

23. Lubricate output shaft with ATF and install forward clutch piston assembly in planetary. Using Piston Housing Compressor, Planetary Holding Fixture and an arbor press, press piston housing down and install internal snap ring. (Figure 22)
24. Check for free rotation of input and output shafts.

Figure 22. Installing Internal Snap Ring

25. Make sure that reverse clutch band and anchor strut are properly positioned, as shown in Figure 23.
26. Lubricate reverse clutch band and output sleeve (Figure 23) with ATF and install planetary assembly in transmission housing.

IMPORTANT: Use extreme care to prevent damaging teflon sealing rings on output sleeve.



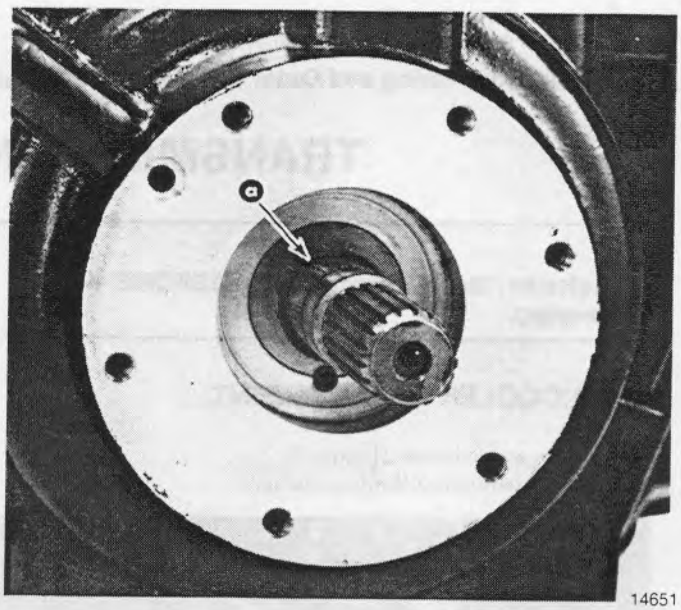
a - Reverse Clutch Band Anchor Strut
b - Clutch Band Long Strut
c - Clutch Band Short Strut
d - Output Sleeve

Figure 23. Reverse Clutch Band Installation

⚠CAUTION

DO NOT drag snap rings across output shaft sealing surface, in next step. Sealing surface MUST BE free of scratches, nicks, etc., or oil leakage may occur. Be sure to install snap rings with sharp edges AWAY from output bearing.

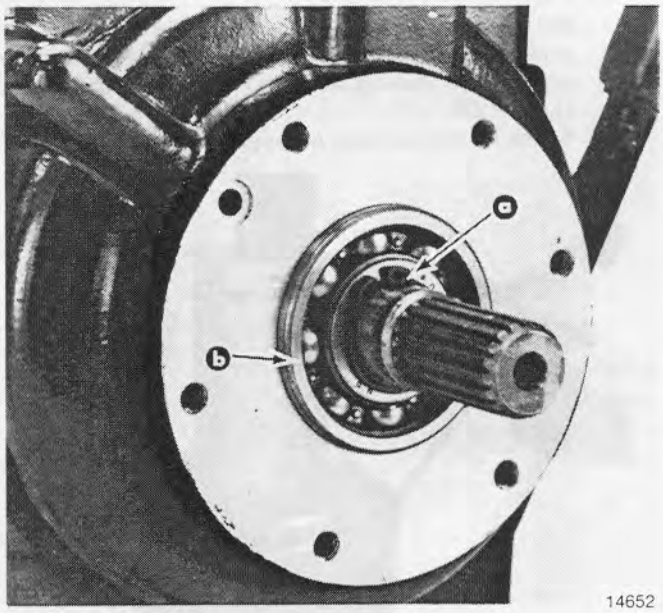
27. Install inner snap ring on output shaft with sharp edge toward transmission housing. (Figure 24)
28. Lubricate outer diameter of output bearing with 2-4-C Multi-Lube and install over output shaft and into transmission housing with numbered side out. Install outer snap ring with sharp edge out. (Figure 25)



a - Inner Snap Ring (Install with Sharp Edge Toward Housing)

Figure 24. Inner Snap Ring Installed

29. Install the following (as outlined).
    a. Gerotor pump.
    b. Control valve housing.
    c. Output housing.
    d. Fluid cooler.
30. Adjust reverse clutch band, as outlined.



14652

a - Outer Snap Ring (Install with Sharp Edge Out)
b - Bearing (Install with Numbered Side Out)

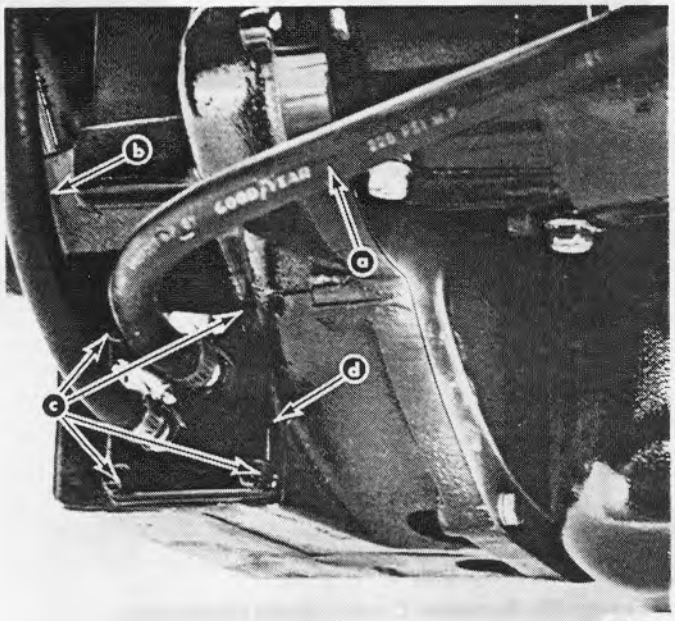
Figure 25. Bearing and Outer Snap Ring Installed

TRANSMISSION HOUSING REPAIR

NOTICE
Refer to "Repair Precautions" BEFORE proceeding.

FLUID COOLER REPLACEMENT

1. Remove water hoses. (Figure 1)
2. Drain transmission fluid as outlined.

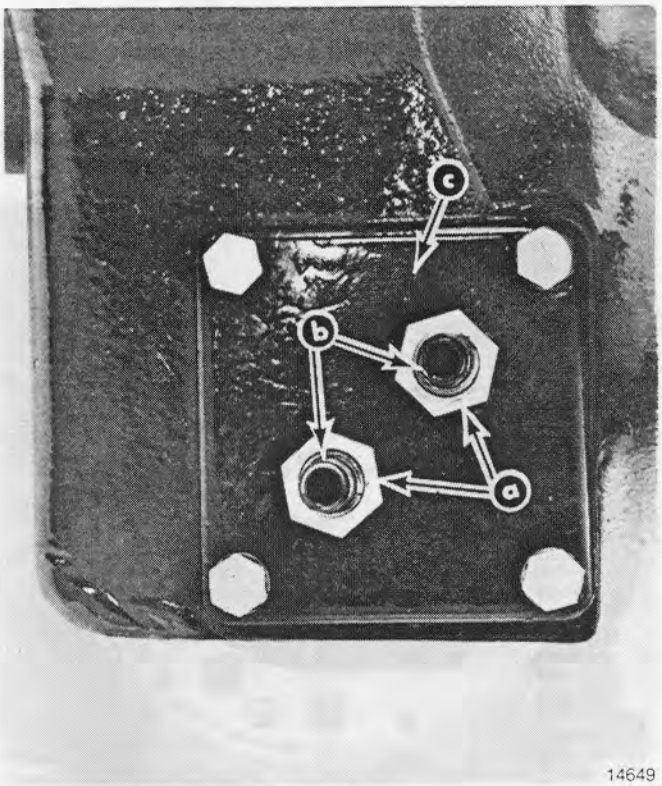


14653

a - Water Inlet Hose (From Seawater Pump)
b - Water Outlet Hose (To Exhaust Elbow)
c - Screws
d - Gasket

Figure 1. Fluid Cooler Replacement

3. Remove screws, then cooler.
4. Check cooler for leaks by plugging one end of cooler and applying 40 psi (276 kPa) of air to the other end while submerging in water.
5. If cooler leaks, remove jam nuts. Remove cooler and "O" rings from cover. (Figure 2)



14649

a - Jam Nuts
b - Cooler Tube
c - Cooler Cover

Figure 2. Cooler Tube Replacement

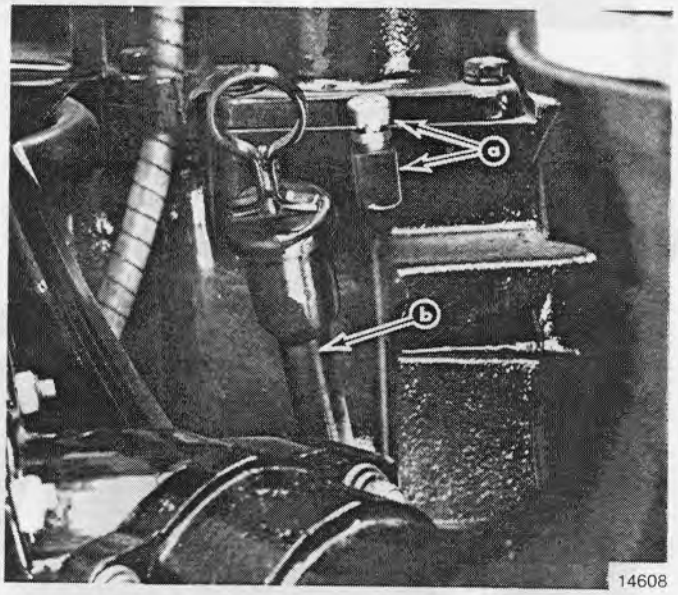
6. Install new "O" rings over fittings on end of cooler tube, then install cooler into cover. Torque jam nuts to specifications.

IMPORTANT: Fluid cooler must be positioned as shown in Figure 1. Rear fitting must be lower than front one.

7. Using new gasket, install fluid cooler into housing.
8. Torque screws to specifications.
9. Reconnect water hoses, tighten clamps securely.
10. Refill transmission with correct fluid, as outlined.

BREATHER VENT/DIPSTICK TUBE

1. Remove breather vent and elbow. (Figure 3)
2. Clean vent. Replace if necessary.



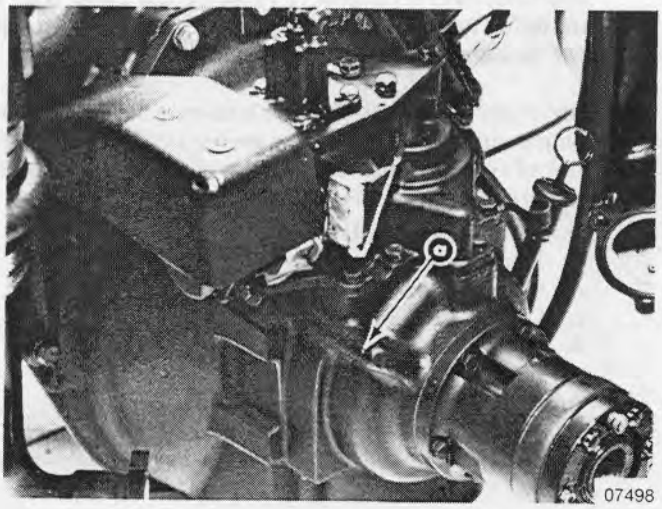
a - Breather Vent and Elbow
b - Dipstick Tube

Figure 3. Breather Vent

3. Install breather vent and elbow. Tighten securely.
4. Remove dipstick tube (if damaged), with vise-grips.
5. If removed, apply Loctite 242 Blue to end of the new distick tube. Tap into transmission housing until it bottoms out.

FLUID PICKUP/REVERSE CLUTCH/HOUSING

1. Remove the following (as outlined):
   a. Fluid cooler.
   b. Output housing.
   c. Control valve housing.
   d. Gerotor pump.
   e. Planetary assembly.
2. Remove allen screw and thin lockwasher, which secure oil fluid pickup flange assembly to transmission housing, and remove flange assembly. Remove "O" ring from flange.
3. Remove reverse clutch band and anchor strut from transmission housing. Loosen jam nut and remove reverse clutch band adjusting screw and sealing washer.
4. Clean and inspect all parts.
5. Inspect fluid pickup screen.
6. Inspect reverse clutch band.
7. Inspect output shaft sleeve in aft end of transmission housing. If damage is severe, new housing must be used.
8. If removed, apply Loctite 242 Blue to a new ¼" diameter sealing ball and drive ball into oil passage. (Figure 4)

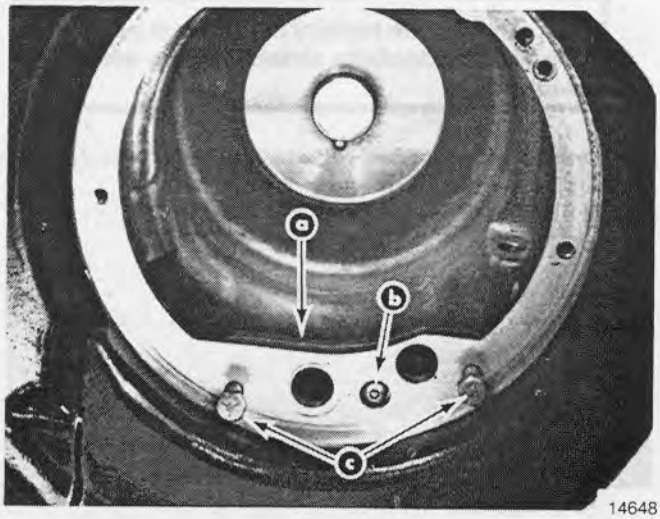


a - 1/4" Diameter Sealing Ball

Figure 4. Sealing Ball

9. Install a new "O" ring in groove of oil pickup flange with 2-4-C Multi-Lube (applied to hold it in place).
10. Position flange assembly in housing, making sure "O" ring does not fall out of groove and secure with thin lockwasher and allen head screw. DO NOT tighten screw.
11. Install 2 pump housing attaching screws (5/16 - 18 thread) into 2 bottom holes (as shown in Figure 5), to align flange assembly, then torque allen head screw to specifications. Remove 2 pump housing attaching screws.

IMPORTANT: Lockwasher used on allen head screw is .047" (1.19mm) thick. DO NOT replace with a thicker lockwasher as this will cause screw to interfer with pump housing.



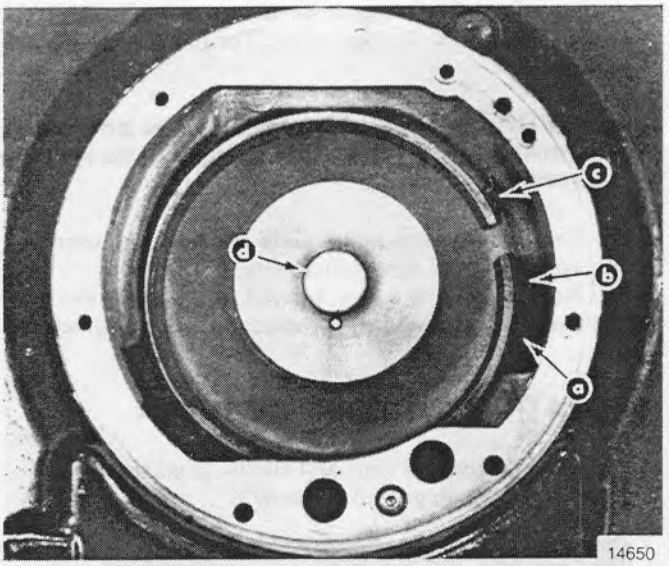
a - Flange Assembly b - Allen Head Screw and Thin Lockwasher
c - Pump Housing Attaching Screws

Figure 5. Flange Assembly Installation

12. Install reverse clutch band adjusting screw and jam nut in transmission housing, using a new sealing washer. DO NOT tighten jam nut at this time.
13. Place reverse clutch band anchor strut on top of adjusting screw. (Figure 6) Turn adjusting screw in so that it just contacts anchor strut.

IMPORTANT: If a new reverse clutch band is to be installed soak band in automatic transmission fluid for 15 minutes, prior to installation.

14. Install reverse clutch band in transmission housing with long strut end of band toward anchor strut. Align tang (in slot of reverse clutch band) with notch in anchor strut. (Figure 6)
15. Install the following (as outlined):
    a. Planetary assembly.
    b. Gerotor pump.
    c. Control valve housing.
    d. Output housing.
    e. Fluid cooler.
16. Adjust reverse clutch band, as outlined.
17. Fill transmission with fluid, as outlined.
18. Apply 2-4-C Multi-Lube to splines on input and output shafts.



a - Reverse Clutch Band Anchor Strut
b - Reverse Clutch Band Long Strut
c - Reverse Clutch Band Short Strut
d - Output Sleeve

Figure 6. Reverse Clutch Band Installation

MECHANICAL SHIFT COVERSION KIT (85789A2)

This mechanical shift kit is designed to replace the electric shift on MerCruiser TR and TRS models. A mechanical shift type remote control and remote control cables also are required in addition to this kit. We recommend using Quicksilver Controls.

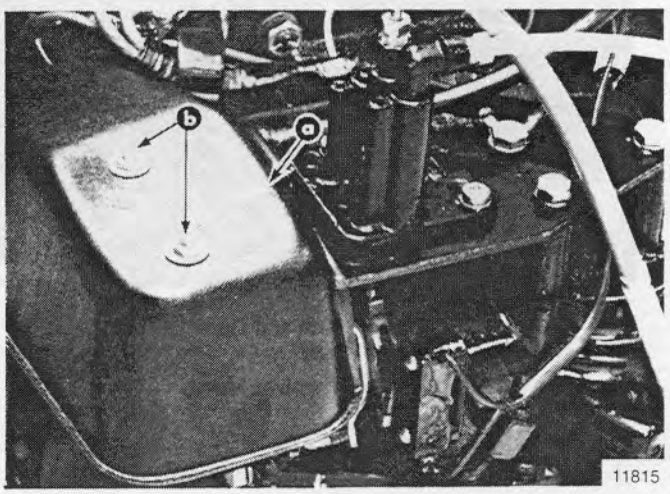
If a control other than Quicksilver is to be used, control must provide a shift cable travel of at least 3" (76 mm) [ideal 3¼"].

INSTALLING MECHANICAL SHIFT ASSEMBLY

⚠CAUTION

Disconnect both battery cables from battery to prevent accidentally shorting wires when installing kit.

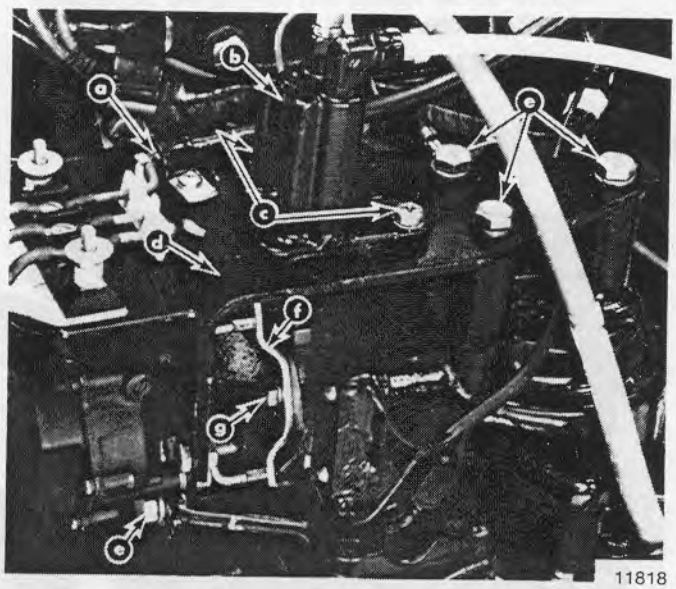
1. Remove shift motor cover attaching nuts, lockwashers and flat washers (Figure 1) and remove cover.



a - Shift Motor Cover
b - Attaching Nuts, Lockwashers and Flat Washers

Figure 1. Removing Shift Motor Cover

2. Disconnect remote control wiring harness leads from terminal block (Figure 2), then remove screw, lockwasher and nut, which secure harness clamp to shift actuator mounting bracket, and remove harness.
3. Remove 2 screws, flat washers and nuts which secure reverse lock valve to shift actuator mounting bracket (Figure 2) and remove valve. Position reverse lock valve out-of-the-way. DO NOT disconnect hydraulic hose or tube. (Retain screws, washers and nuts.)
4. Remove 4 screws and lockwashers, which secure shift actuator mounting bracket to control valve (Figure 2), and remove shift actuator and mounting bracket assembly. (Retain short screw and 4 lockwashers.)



11818

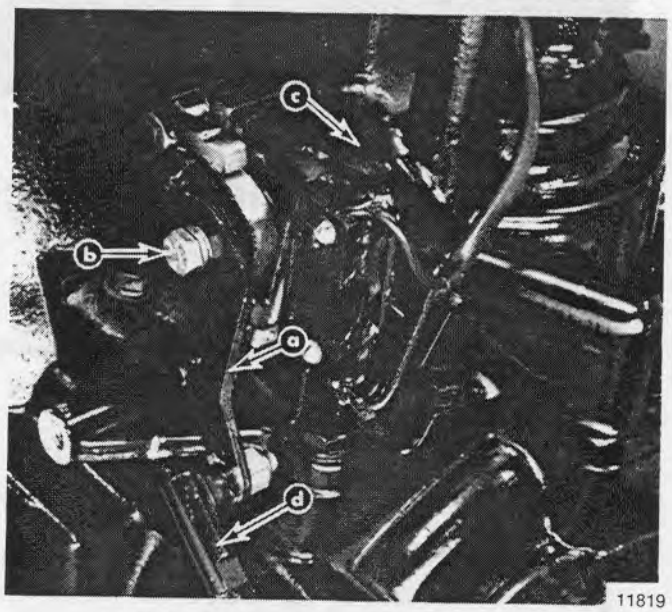
a - Remote Contol Wiring Harness
b - Reverse Lock Valve
c - Screws and Flat Washers (Secured on Opposite Side with Nuts)
d - Mounting Bracket
e - Mounting Bracket Screw and Lockwasher
f - Shift Link
g - Shift Link Screw and Lockwasher

Figure 2. Removing Electric Shift Actuator

5. Remove screw and lockwasher, which secure shift link to transmission control valve (Figure 2), and remove shift link. (Retain screw and lockwasher.)
6. Attach shift lever (on end of mechanical shift linkage) to transmission control valve and secure with screw and lockwasher which were retained in Step 5. (Figure 3) Tighten screw securely.
7. Attach reverse lock valve to mounting bracket (from kit) with 2 screws, flat washers and nuts which were retained in Step 3. (Figure 4) Place flat washers between head of screws and reverse lock valve. Tighten screws securely.

⚠CAUTION

Be sure that cam follower is in position on control valve cam and that reverse lock valve plunger is centered on cam follower, when installing valve in the following steps. If reverse lock valve is not installed correctly, drive unit may be locked in the down position while in neutral or forward gear, and severe damage could occur, if an underwater object is struck.

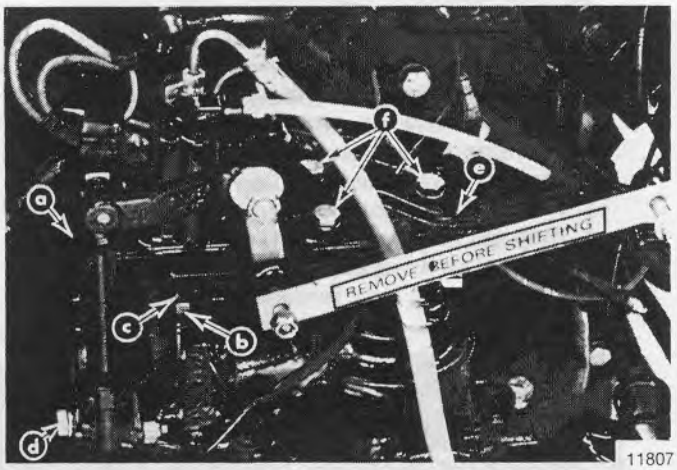


11819

a - Shift Lever
b - Screw and Lockwasher (Retained in Step 5)
c - Transmission Control Valve
d - Mechanical Shift Linkage

Figure 3. Shift Lever Attached to Transmission Control Valve

8. Lubricate plunger on bottom of reverse lock valve with 2-4-C Multi-Lube, then place reverse lock valve and mounting bracket assembly in position on transmission and align plunger with cam follower on control valve. (Figure 4)
9. Place mechanical shift mounting bracket in position on top of reverse lock valve mounting bracket and secure both to control valve wwith three 1⅛" (29mm) long screws from kit and screw and 4 lockwashers which were retained in Step 4. (Figure 4) Be sure that reverse lock valve plunger remains centered with cam follower. Tighten screws securely.
10. Adjust throttle and shift cabels as outlined in "Section 2, Part F".



a - Reverse Lock Valve Mounting Bracket
b - Cam Follower
c - Reverse Lock Valve Plunger (Must Be Centered on Top of Cam Follower)
d - Screw and Lockwasher (Retained in Step 4)
e - Shift Bracket
f - Screws [1-1/18" (29mm) long from kit] and Lockwashers (Retained in Step 4)

Figure 4. Mechanical Shift Assembly Installed

ELECTRIC SHIFT CONVERSION KIT (69392A1)

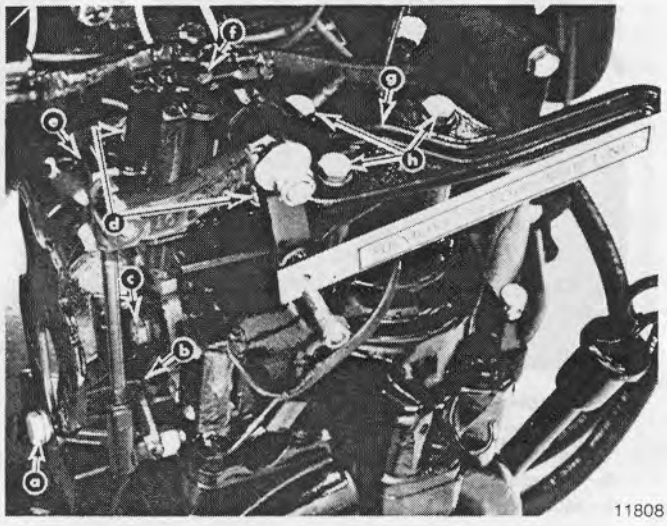
This Electric Shift Kit is designed to replace the standard mechanical shift on MerCruiser TR and TRS models. An electric shift remote control also is required when installing this kit.

INSTALLING ELECTRIC SHIFT UNIT

⚠CAUTION

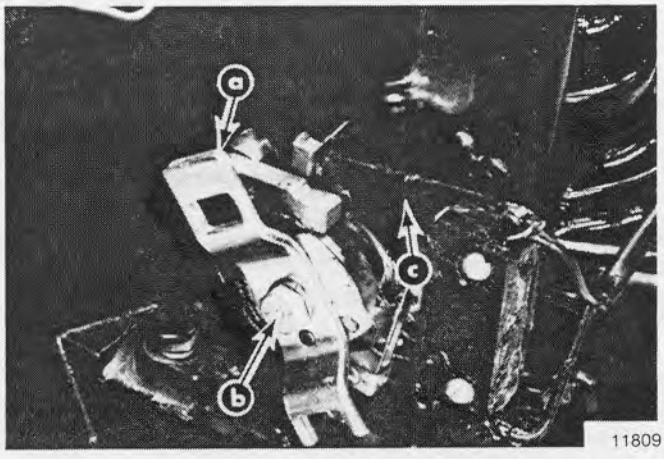
If engine has already been installed, disconnect both battery cables from battery to prevent accidentally shorting wires when installing kit.

1. Remove 4 screws and lockwashers, which secure mechanical shift and reverse lock valve mounting brackets to transmission control valve (Figure 1), then remove reverse lock valve and mounting bracket assembly. (Retain lockwashers.)
2. Remove 2 screws, flat washers and nuts, which secure reverse lock valve to mounting bracket (Figure 1), and remove valve. (Retain valve, screws, washers and nuts.)
3. Remove shift arm attaching screw and lockwashers (Figure 1), then disconnect arm from valve and remove mechanical shift assembly. (Retain screw and lockwasher.)
4. Attach shift link (from kit) to transmission control valve and secure with screw and lockwasher which were retained in Step 3. (Figure 2) Tighten screw securely.



a - Mounting Bracket Screw and Lockwasher
b - Shift Arm
c - Shift Arm Screw and Lockwasher
d - Screws and Flat Washers (Secured on Opposite Side with Nuts)
e - Reverse Lock Valve Mounting Bracket
f - Reverse Lock Valve
g - Mechanical Shift Mounting Bracket
h - Screws and Lockwashers

Figure 1. Removing Mechanical Shift Assembly



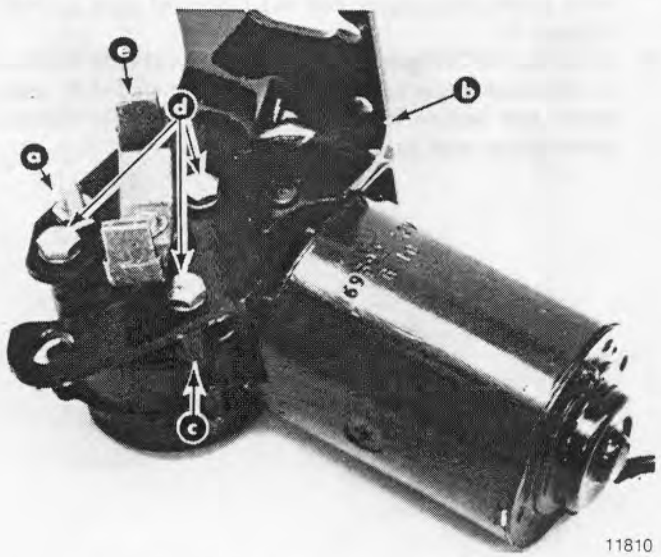
a - Shift Link
b - Screw and Lockwasher (Retained in Step 3)
c - Control Valve

Figure 2. Shift Link Attached to Transmission Control Valve

5. If not already done, install ¾" (19mm) long screw (from kit) thru electric shift mounting bracket and secure with locknut (from kit), as shown in Figure 3. Tighten nut securely.

IMPORTANT: When moving shift actuator arm, in next step, leave shift motor leads attached until shift actuator has completed its cycle. Failure to do this, may allow arm (and switch mechanism) to coast beyond forward or reverse limits and render shift motor inoperative.

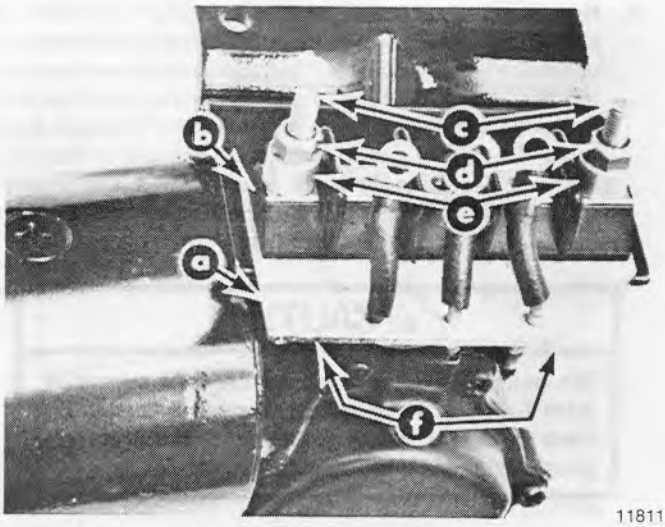
6. Apply Loctite "A" to threads of three ⅝" (16mm) long screws (from kit), and attach electric shift actuator to mounting bracket with screws and lockwashers (from kit). (Figure 3) It will be necessary to move actuator arm to install all three screws. To do this, connect black shift motor lead (ground) to negative (–) battery terminal and green, blue or orange shift motor lead to positive (+) battery teminal. After all three screws and lockwashers have been installed, tighten screws securely.
7. If not already done, attach shift motor leads support plate and terminal block to mounting bracket with two 1⅜" (35mm) long screws, lockwashers, spacers and locknuts (from kit), as shown in Figure 4. Tighten nuts securely.
8. Shift electric shift actuator into reverse position by connecting shift motor black (ground) lead to negative (–) battery terminal and shift motor blue lead to positve (+) battery terminal. Be sure to allow shift actuator to complete its cycle.



11810

a - Screw [3/4" (19mm) Long] and Locknut
b - Mounting Bracket
c - Electric Shift Actuator
d - Screws [5/8" (19mm) Long] and Lockwashers
e - Actuator Arm

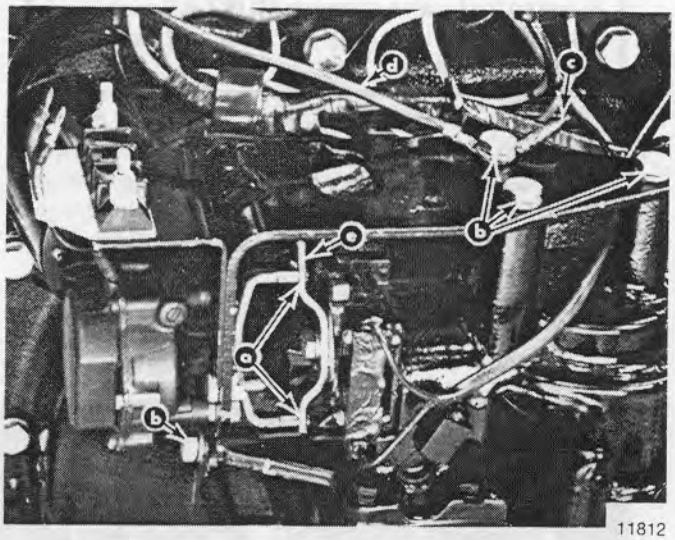
Figure 3. Actuator Attached to Mounting Bracket



11811

a - Shift Motor Leads Support Plate
b - Terminal Block
c - Screws [1-3/8" (35mm) Long]
d - Locknuts
e - Spacers
f - Lockwashers (Hidden)

Figure 4. Support Plate and Terminal Block Attached to Mounting Bracket



11812

a - Shift Link and Actuator Arm Aligned
b - Screws [3/4" (19mm) Long; from kit] and Lockwashers (Retained in Step 1)
c - Neutral Start Safety Switch Ground Lead
d - Shift Motor Ground Lead
e - Shift Link Large End

Figure 5. Shift Actuator and Mounting Bracket Assembly Attached to Control Valve

9. Hold shift actuator and mounting bracket assembly in position along side control valve. Align link (with large end upward) with actuator arm, then slide actuator and mounting bracket assembly into place. Secure actuator and mounting bracket assembly with four ¾" (19mm) long screws (from kit) and lockwashers (retained in Step 1), connecting shift motor black (ground) lead and neutral start safety switch lead to front screw. (Figure 5) Tighten screws finger-tight only at this time.

⚠CAUTION

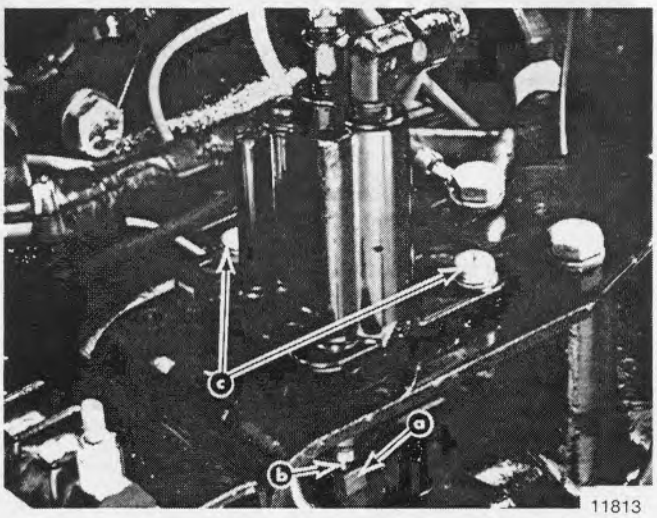
When installing valve in next step, be sure that cam follower is in position on control valve cam and that reverse lock valve plunger is properly aligned with cam follower.

10. Coat reverse lock valve plunger with 2-4-C Multi-Lube. Place reverse lock valve in position in mounting bracket and align plunger with cam follower on control valve (Figure 6), then secure valve with 2 screws, flat washers and locknuts (retained in Step 2). Tighten screws securely.

⚠WARNING

Reverse lock valve plunger MUST BE well lubricated or plunger may corrode and hang-up during operation.

11. Move shift actuator mounting bracket (right or left, as required) to center reverse lock valve plunger on cam follower and tighten mounting bracket attaching screws (installed in Step 9) securely. Coat screw, to which ground wires are attached, with Liquid Neoprene.



a - Cam Follower
b - Reverse Lock Valve Plunger
c - Screws and Flat Washers Secured on Opposite Side with Locknuts (Retained in Step 2)

Figure 6. Reverse Lock Valve Installed

REMOTE CONTROL WIRING CONNECTIONS

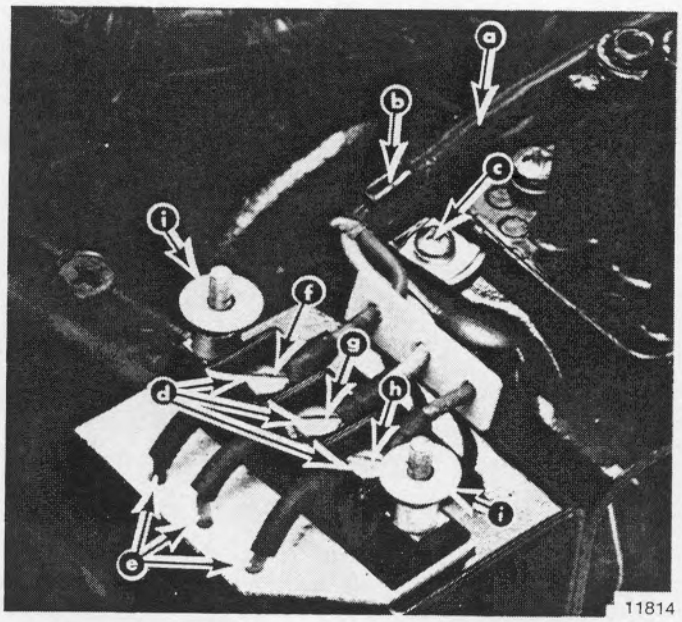
⚠CAUTION

Be sure that battery cables are disconnected when making the following electrical connections.

1. Install electric shift remote control in boat in accordance with instructions which accompany control.
2. Connect white wire from remote control to 12-volt switched terminal (terminal with white or purple wires already attached) on tachometer.
3. Route wiring harness back to electric shift actuator, making sure that it does not rub or get pinched and that it does not come in contact with bilge water. Fasten harness to boat at least once every 18" (455cm) with appropriate fasteners.

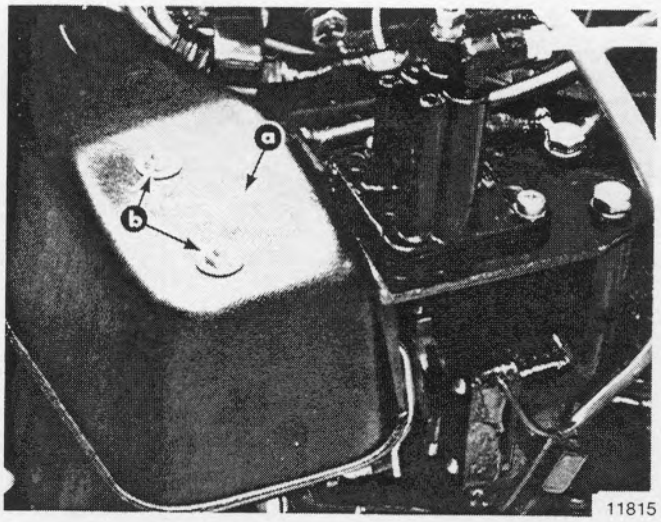
IMPORTANT: Be sure to match color-coded leads correctly when connecting leads (in next step). If leads are mixed, transmission failure will occur.

4. Match color-coded wiring harness leads with shift motor leads and connect leads to terminal block with ¼" (6mm) long screws (from kit). (Figure 7) Coat connections with Liquid Neoprene.
5. Fasten wiring harness clamp to actuator mounting bracket with screw, lockwasher and nut (supplied with control). (Figure 7)
6. Place one ¾" (19mm) OD flat washer over each terminal block mounting screw (Figure 7), then install shift motor cover and secure with remaining ¾" OD flat washers, lockwashers and nuts. (Figure 8)



a - Electric Shift Remote Control Wiring Harness
b - Clamp
c - Screw Secured on Opposite Side with Lockwasher and Nut (All Parts Supplied with Control)
d - Screws [1/4" (6mm) Long]
e - Shift Motor Leads
f - Green Lead Terminal
g - Orange Lead Terminal
h - Blue Lead Terminal
i - Flat Washer

Figure 7. Wiring Harness and Shift Motor Leads Connected to Terminal Block

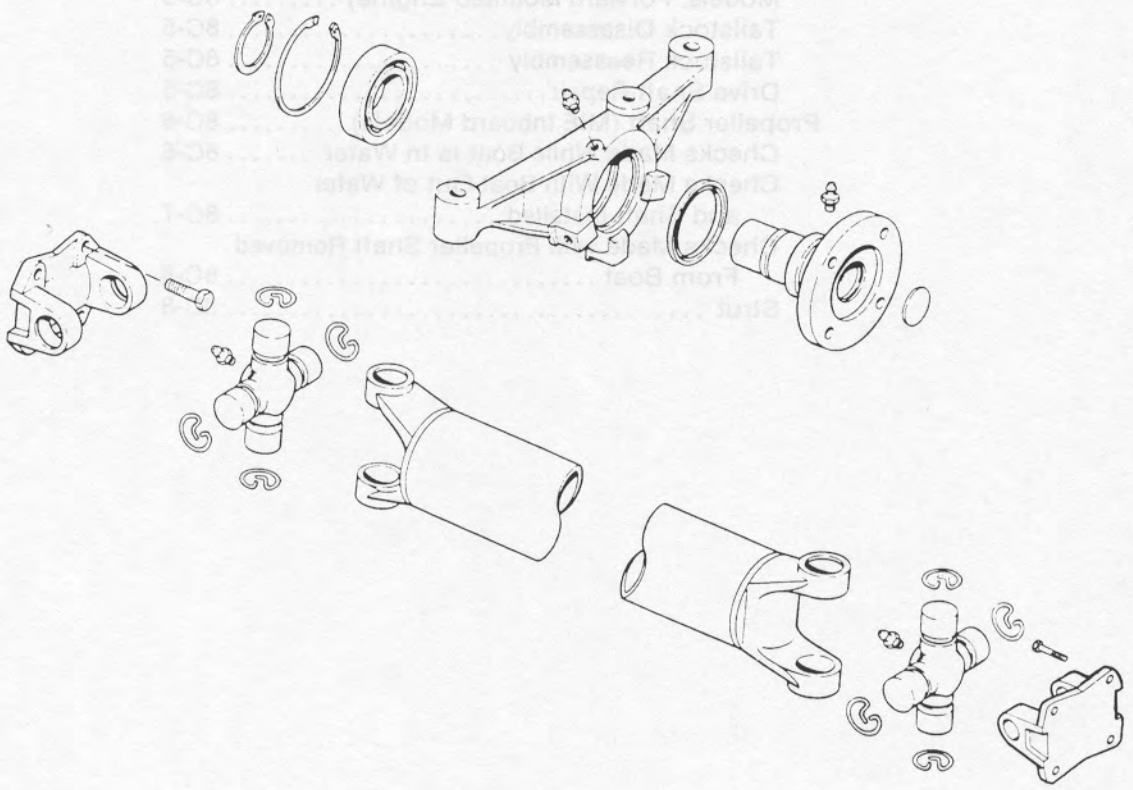


a - Shift Motor Cover
b - Flat Washers, Lockwashers and Nuts

Figure 8. Shift Motor Cover Installed

SECTION 8 - DRIVE SYSTEM

PART C - DRIVE SHAFT MODELS/PROPELLER SHAFT



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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Driveshaft to Tailstock Flange (MCM 370/Hi-Performance Models)	50 (68) (Note 1)
Driveshaft to Transmission Output Flange (MCM 370/ Hi-Performance Models)	35 (48)
Driveshaft to Bearing Support Flange (MCM 120 - 260)	50 (68)
Driveshaft to Output Shaft (MCM 120-260)	50 (68)
Output Housing to Tailstock Housing (MCM 370/ Hi-Performance Models)	18 (24)
Flywheel Housing to Block (MCM 120 - 260)	30 (41)
Engine Coupling	35 (48)
Output Shaft Housing to Flywheel Housing (MCM 120 - 260)	30 (41)
Propeller Shaft Coupling to Transmission Coupling (MIE Models)	50 (68)

NOTE: 1 Secure with safety wire.

TOOLS/LUBRICANTS/SEALANTS

TOOLS/LUBRICANTS/SEALANTS	
91-34569A1	Slide Hammer Puller
92-86154A1	Quicksilver 2-4-C Multi-Lube
92-32609--1	Quicksilver Loctite A

OBTAIN LOCALLY
Loctite 290

FLYWHEEL HOUSING/OUTPUT SHAFT HOUSING REPAIR (MCM 120R/140R/898/228/260)

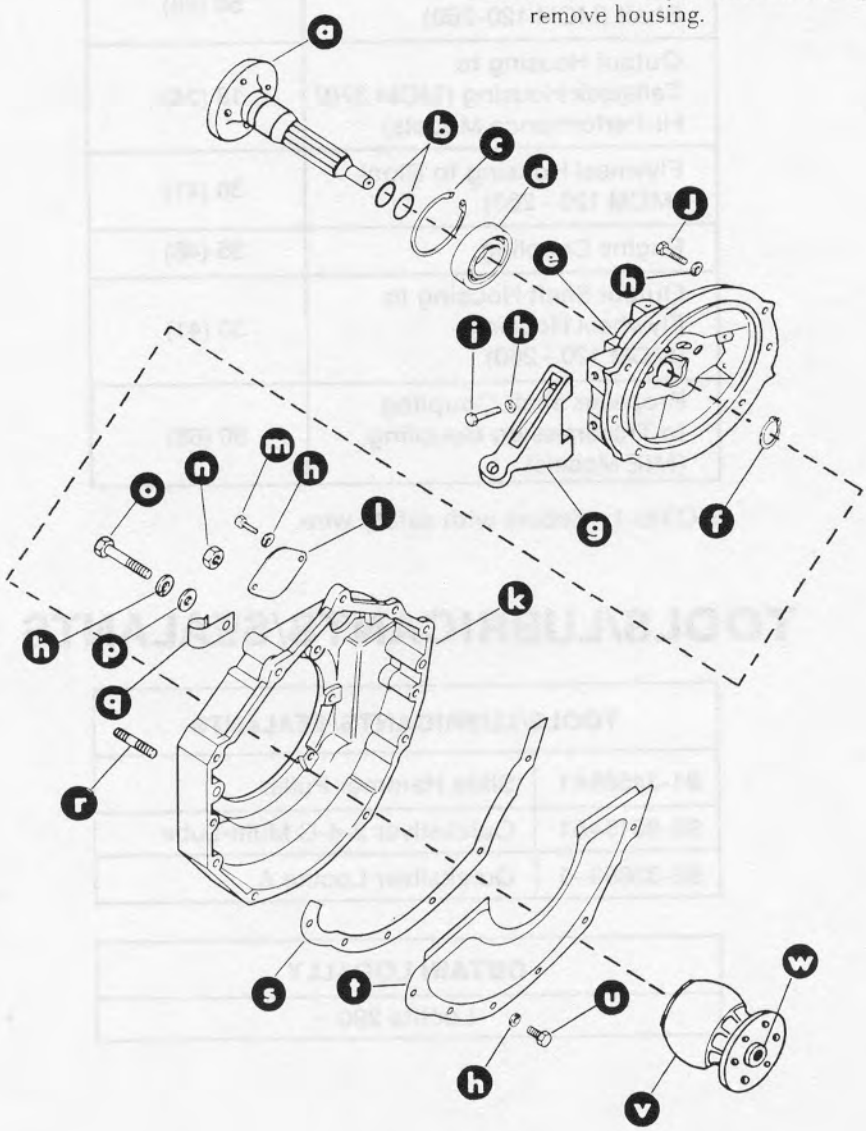
REMOVAL/INSTALLATION

NOTICE
For removal and installation of drive shaft and engine (if required), refer to the following: MCM 120R/140R Models: "Section 2, Part B". MCM 898/228/260 Models: "Section 2, Part E".

DISASSEMBLY (Figure 1)

IMPORTANT: Refer to "Section 2, Part B or E", BEFORE proceeding. The following proceedure is outlined, so that engine does not have to be removed from the boat.

1. Disconnect drive shaft as outlined.
2. Support rear of engine with overhead hoist or wooden blocks under the rear of the engine.
3. Remove stringer bolts (rear engine mounts).
4. Remove output shaft housing attaching screws, then remove housing.



a - Output Shaft
b - "O" Rings
c - Snap Ring - Ball Bearing
d - Ball Bearing
e - Shaft Housing
f - Snap Ring - Output Shaft
g - Rear Engine Mount (2)
h - Lockwasher
i - Screw (4)
j - Screw (6)
k - Flywheel Housing
l - Plate
m - Screw (2)
n - Nut (1)
o - Screw (4)
p - Washer (1)
q - Clamp (1)
r - Stud (1)
s - Gasket
t - Cover - Flywheel
u - Screw (7)
v - Coupling - Engine
w - Bushing

Figure 1. Flywheel Housing/Output Shaft Housing

5. Remove snap ring, then pull output shaft out of housing.
6. Remove snap ring from housing.
7. Using Slide Hammer Puller, remove bearing from housing.
8. Remove flywheel cover.
9. Remove flywheel housing.
10. Remove engine coupling.
11. Clean and inspect all parts. Replace any damaged parts.

REASSEMBLY (Figure 1)

1. Install engine coupling. Torque to specifications.
2. Install flywheel housing. Torque to specifications.
3. Using new gasket, install flywheel cover. Tighten screws securely.

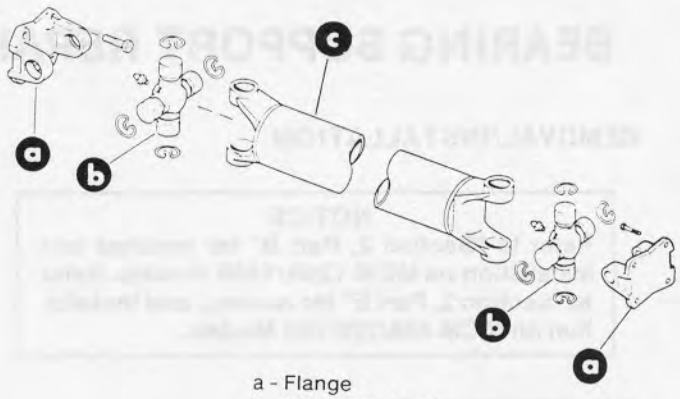
IMPORTANT: Groove in outside diameter of ball bearing must align with grease fitting hole.

4. Install ball bearing into output shaft housing, then install snap ring.
5. Apply 2-4-C Multi-Lube to "O" rings (on output shaft), then slide shaft thru bearing. Secure shaft with snap ring.
6. Apply 2-4-C Multi-Lube to splines on output shaft.
7. Install output shaft housing to flywheel housing. Torque screws to specifications.
8. Secure rear engine mounts to stringer with bolts. Tighten securely.
9. Remove hoist (or wooden blocks).
10. Reconnect drive shaft and check alignment as outlined.
11. Using 2-4-C Multi-Lube, grease ball bearing thru grease fitting.

DRIVE SHAFT REPAIR (MCM 120R/140R/898/228/260)

REMOVAL/INSTALLATION

NOTICE
Refer to "Section 2, Part B" for removal and installation on MCM 120R/140R Models. Refer to "Section 2, Part E" for removal and installation on MCM 898/228/260 Models.



a - Flange
b - Universal Joint
c - Drive Shaft

Figure 1. Drive Shaft

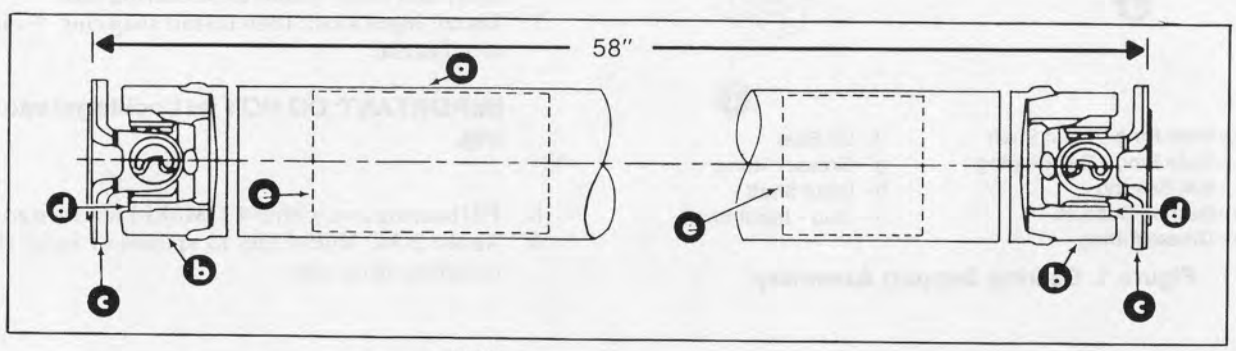
REPAIR (Figure 1)

1. Replace universal joints if required.
2. Replace flange if required.

⚠CAUTION
Be sure universal joint locking rings are seated properly after replacing universal joint.

REPLACEMENT DRIVE SHAFTS

Currently, MerCruiser is furnishing a standard 58" long drive shaft (Figure 2) with all Extension Shaft Models listed above. Some boat manufacturers modify the drive shafts to a shorter length. Because of this, use the following procedure to obtain replacement drive shafts.



a - Tube
b - Yoke - Tube
c - Flange
d - Universal Joint
e - Sound Deadener (Cardboard Tube)

Figure 2. Extension Drive Shaft

58" Long (Standard Length) Drive Shaft:

The complete drive shaft can be ordered from Mercury Marine.

Drive Shafts Modified to Shorter Lengths:

The complete modified (shortened) drive shaft has to be ordered from the boat manufacturer that installed the MerCruiser Power Package.

IMPORTANT: Dana Corporation - Spicer Regional Drive Shaft Centers WILL NOT shorten replacement drive shafts for dealers or consumers.

⚠CAUTION

If a boat manufacturer is currently having Extension Drive Shafts modified, they MUST BE modified by one of Dana Corporation - Spicer Regional Drive Shaft Centers to maintain Mercury Marine warranty. The modified drive shaft MUST MEET the following specifications.

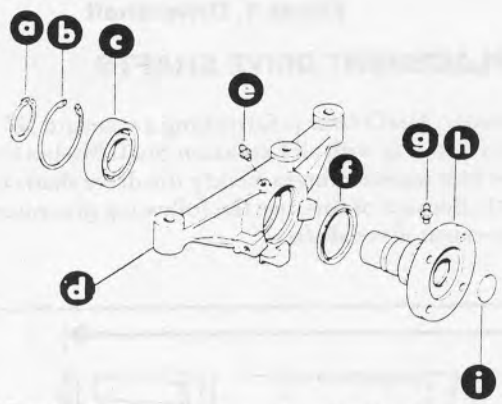
- **U-joints aligned radially within 0° (±1/2°).**
- **U-joints greased after welding with Quicksilver 2-4-C Multi-Lube.**
- **Assembly balanced to within 1.5 oz. in. to 4500 RPM.**
- **Tube to have .005" - .010" interference fit with tube yoke.**
- **Tube must be straight and round within .015" T.I.R.**

BEARING SUPPORT REPAIR (MCM 120R/140R/898/228/260)

REMOVAL/INSTALLATION

NOTICE
Refer to "Section 2, Part B" for removal and installation on MCM 120R/140R Models. Refer to "Section 2, Part E" for removal and installation on MCM 898/228/260 Models.

DISASSEMBLY (Figure 1)



a - Snap Ring - Input Shaft
b - Snap Ring - Ball Bearing
c - Ball Bearing
d - Bearing Support
e - Grease Fitting
f - Oil Seal
g - Grease Fitting
h - Input Shaft
i - Plug - Input Shaft

Figure 1. Bearing Support Assembly

1. Remove snap ring, then remove input shaft.
2. Remove larger snap ring.
3. Using Slide Hammer Puller, remove ball bearing.
4. Remove oil seal.
5. If required, remove plug from end of input shaft.
6. Clean and inspect all parts.
7. Replace any damaged parts.

REASSEMBLY (Figure 1)

1. If removed, install new plug in end of input shaft.
2. Apply Loctite A to outer diameter of new oil seal.
3. Press oil seal into bearing support. Lip of seal faces away from ball bearing.
4. Apply Loctite 290 to outer deameter of ball bearing and inner diameter of bearing support.
5. Install bearing (with sealed side toward snap ring) by using a press. After installation, wipe up excessive Loctite. Install snap ring.
6. Apply Loctite 290 to outer diameter of input shaft (bearing area) and inside diameter of bearing race.
7. Install input shaft, then install snap ring. Wipe up excessive Loctite.

IMPORTANT: DO NOT let Loctite get into ball bearing.

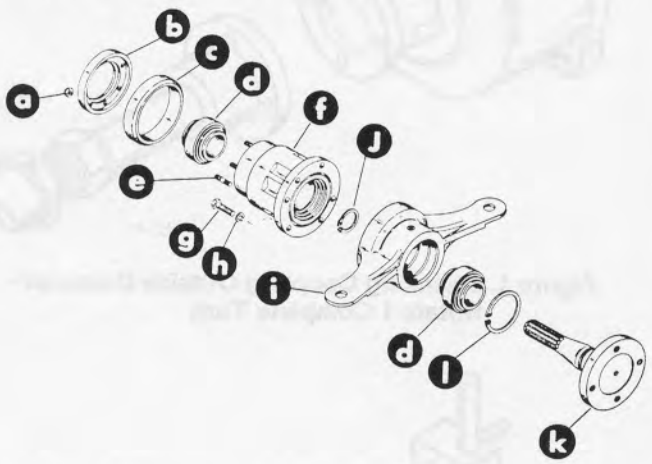
8. Fill bearing area with 2-4-C Multi-Lube thru grease fitting.
9. Apply 2-4-C Multi-Lube to splines of input shaft before installing drive unit.

TAILSTOCK ASSEMBLY/DRIVE SHAFT REPAIR (MCM 370/ HI-PERFORMANCE MODELS, FORWARD MOUNTED ENGINE)

REMOVAL/INSTALLATION

NOTICE
Refer to "Section 2, Part H", BEFORE proceeding and for removal and installation.

TAILSTOCK DISASSEMBLY (Figure 1)



a - Nut (6)
b - Retainer
c - Rubber Mount
d - Ball Bearing (2)
e - Stud (6)
f - Output Housing
g - Screw (6)
h - Lockwasher (6)
i - Tailstock Housing
j - Snap Ring - Tailstock Shaft
k - Tailstock Shaft
l - Snap Ring - Tailstock Housing

Figure 1. Tailstock Assembly

1. Remove nuts, retainer and rubber mount from output housing, then remove ball bearing.
2. Remove screws and then separate output housing from tailstock housing.
3. Remove tailstock shaft snap ring then slide shaft out of tailstock housing.
4. Remove snap ring from tailstock, then remove ball bearing.
5. Clean and inspect all parts. Replace any damaged parts.

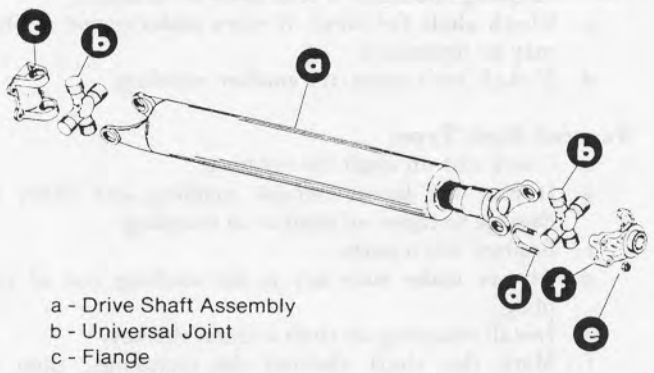
TAILSTOCK REASSEMBLY (Figure 1)

IMPORTANT: Groove in outside diameter of ball bearings must align with grease fitting holes.

1. Install ball bearing into tailstock housing, then install snap ring.
2. Apply 2-4-C Multi-Lube to splines of tailstock shaft.
3. Slide shaft thru bearing, then secure with snap ring.
4. Apply Loctite A to threads of output housing attaching screws.
5. Assemble output housing to tailstock housing. Torque screws to specifications.
6. Install ball bearing.
7. Apply Loctite A to output housing studs.
8. Install rubber mount, retainer and nuts.
9. Grease both bearings with 2-4-C Multi-Lube.

DRIVE SHAFT REPAIR (Figure 2)

NOTICE
Refer to "Section 2, Part H", BEFORE proceeding.



a - Drive Shaft Assembly
b - Universal Joint
c - Flange
d - U Bolt (2)
e - U Bolt Nut (4)
f - Yoke - For Replacement, Refer to "Section 8, Part A"

Figure 2. Drive Shaft Assembly

1. Replace universal joints, if required.
2. Replace flange, if required.
3. Drive shaft cannot be repaired. Order complete replacement assembly (from Mercury Marine) if required.

PROPELLER SHAFT (MIE INBOARD MODELS)

NOTICE

The following information can be used as a guide for determining vibration problems on boats powered by inboard engines (MIE Models). For installation, alignment and repairs to shafts, struts, shaft logs and rudders, refer to boat manufactures service manual. If boat is equipped with a remote mounted V-Drive, refer to V-Drive or boat manufactures service manual for all servicing and troubleshooting. For MIE engine installation and alignment, refer to 'Section2, Part I".

CHECKS MADE WHILE BOAT IS IN WATER

1. Disconnect propeller shaft coupling from transmission coupling.
2. Check fit of coupling to propeller shaft.

Straight Bore Type:

a. Loosen set screws.
b. Try to move coupling by hand. The bore of the coupling should be a semi press fit to shaft.
c. Check shaft for wear. If worn replacement of shaft may be necessary.
d. If shaft isn't worn, try another coupling.

Tapered Bore Type:

a. Check nut on shaft for tightness.
b. If nut was loose, remove coupling and check for damage to taper on shaft or in coupling.
c. Replace worn parts.
d Always make sure key is not sticking out of coupling.
e. Install coupling on shaft without the key.
f. Mark the shaft (behind the coupling), then remove the coupling.
g. Now install the key and coupling Make sure coupling still lines up with the mark. This ensures that key is not oversize and holding the tapers apart.

3. Check output coupling flange of transmission. (Figures 1 and 2)
4. If there is movement in step 3, replace output coupling.
5. Replace damaged parts and realign engine as outlined.

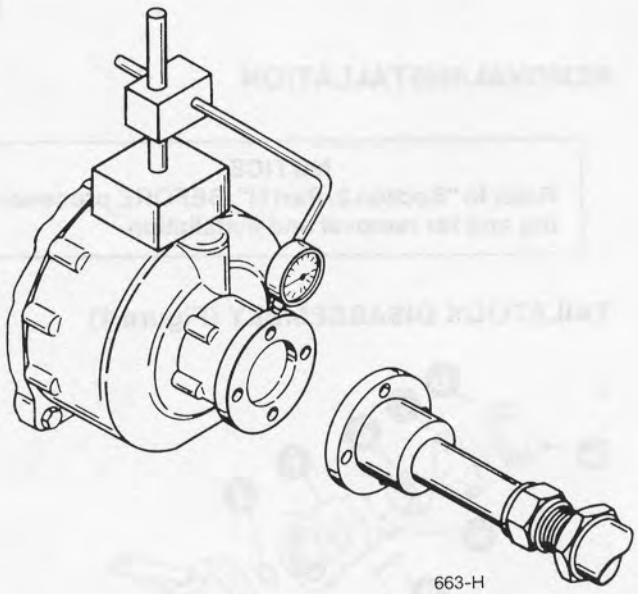


Figure 1. Checking Coupling Outside Diameter - Rotate 1 Complete Turn

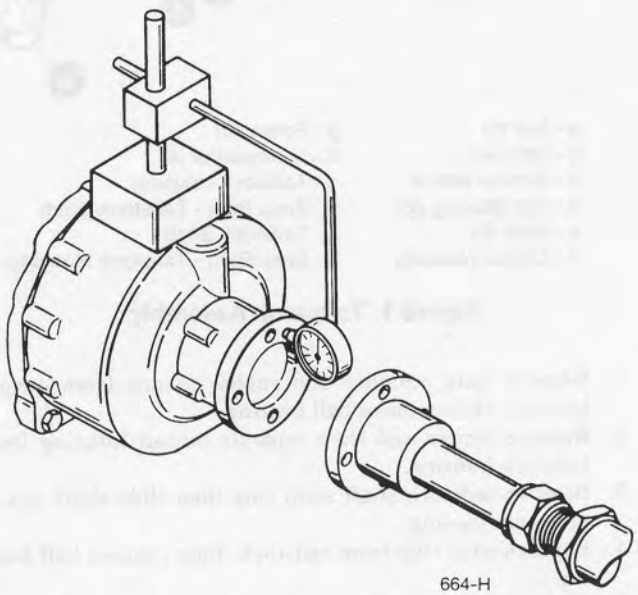
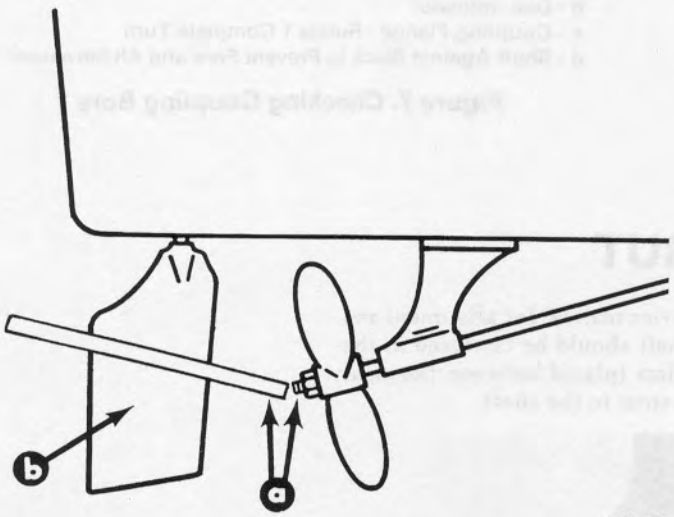


Figure 2. Checking Coupling Face - Rotate 1 Complete Turn

CHECKS MADE WITH BOAT OUT OF WATER and SHAFT INSTALLED

Possible causes for vibration could be propeller shaft, propeller to shaft fit or propeller. All three can be checked by using the rudder, a strong metal straight edge and a "C" clamp.

1. Check installation of propeller to shaft.
   a. Remove propeller.
   b. Check for chipped or cracked keyway in propeller on shaft without key.
   c. Install propeller on shaft without key.
   d. Mark the shaft (behind the propeller), then remove propeller.
   e. Install the key and propeller. Make sure propeller still lines up with mark. This ensures that key is not oversize and holding the tapers apart. Retighten propeller nut.
   f. Be sure key is not sticking out of propeller.
2. Check for propeller shaft being bent behind the strut. (Figure 3)

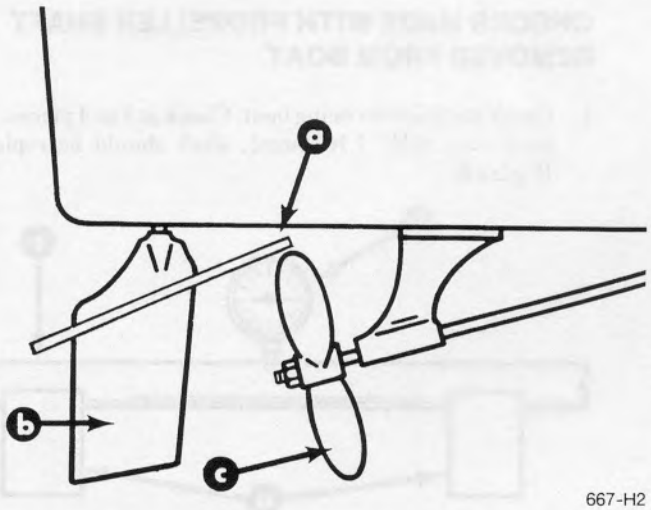


667-H1

a - Metal Straight Edge (Held to Rudder with'C" Clamp) - Position Corner of Straight Edge at Center of Shaft. Rotate Shaft 1 Complete Turn. If Shaft "Wobbles", Replace Shaft.
b. - Rudder

Figure 3. Checking for Bent Shaft

3. Check the diameter of all propeller blades. If not the same, repair propeller. (Figure 4)

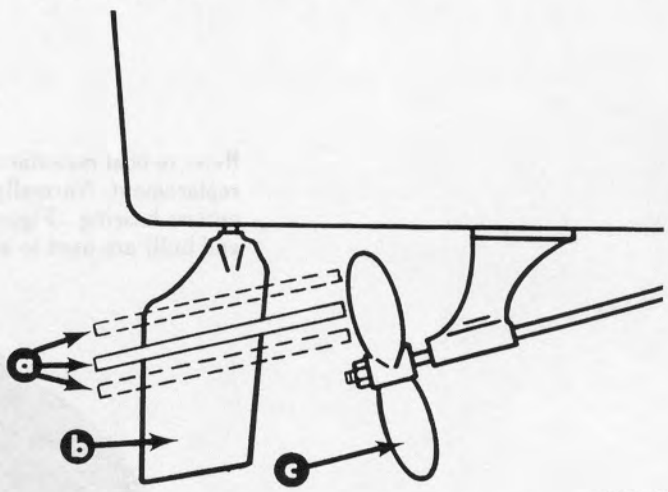


667-H2

a - Metal Straight Edge (Held to Rudder with 'C" Clamp)
b - Rudder
c - Rotate Propeller 1 Complete Turn

Figure 4. Checking Propeller Diameter

4. Check that all propeller blades are the same pitch and that it is properly seated on shaft. Repair or replace if necessary. (Figure 5)



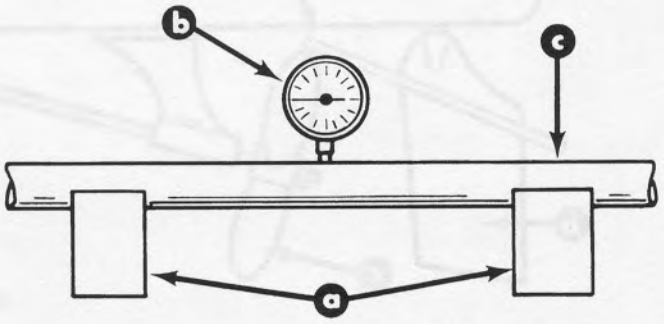
667-H3

a - Metal Straight Edge (Held to Rudder with "C" Clamp)
b - Rudder
c - Rotate Propeller 1 Complete Turn. Check at 3 Different Points on Blades

Figure 5. Checking Propeller Pitch and for Proper Seating

CHECKS MADE WITH PROPELLER SHAFT REMOVED FROM BOAT

1. Check the shaft for being bent. Check at 3 or 4 places. Any bend over .004" (.1016mm), shaft should be replaced. (Figure 6)

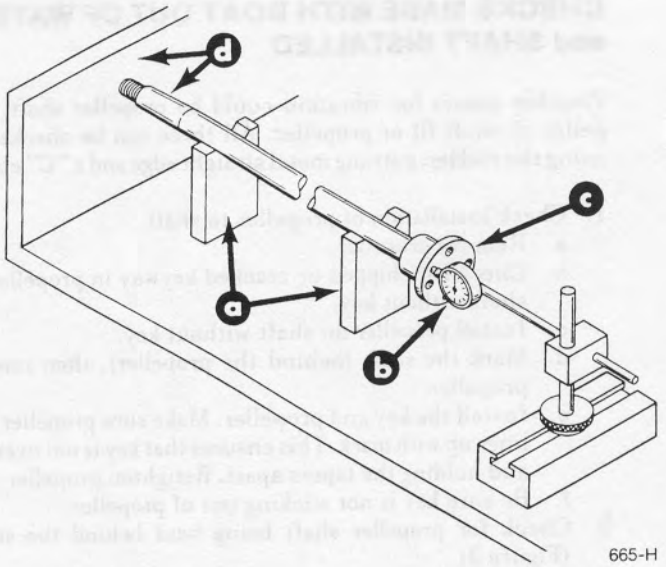


666-H

a - Vee Blocks
b - Dial Indicator
c - Shaft - Rotate 1 Complete Turn

Figure 6. Checking for Bent Shaft.

2. Check that bore of coupling is 90 degrees from coupling flange. Replace coupling if needle moves. (Figure 7)



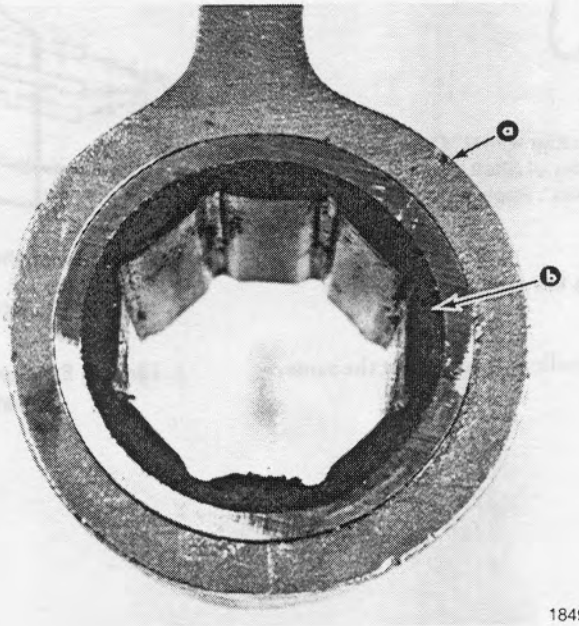
665-H

a - Vee Blocks
b - Dial Indicator
c - Coupling Flange - Rotate 1 Complete Turn
d - Shaft Against Block to Prevent Fore and Aft Movement

Figure 7. Checking Coupling Bore

STRUT

Refer to boat manufactures service manual for alignment and replacement. Normally, the shaft should be centered in the cutlass bearing. (Figure 8) Shims (placed between the strut and hull) are used to align the strut to the shaft.

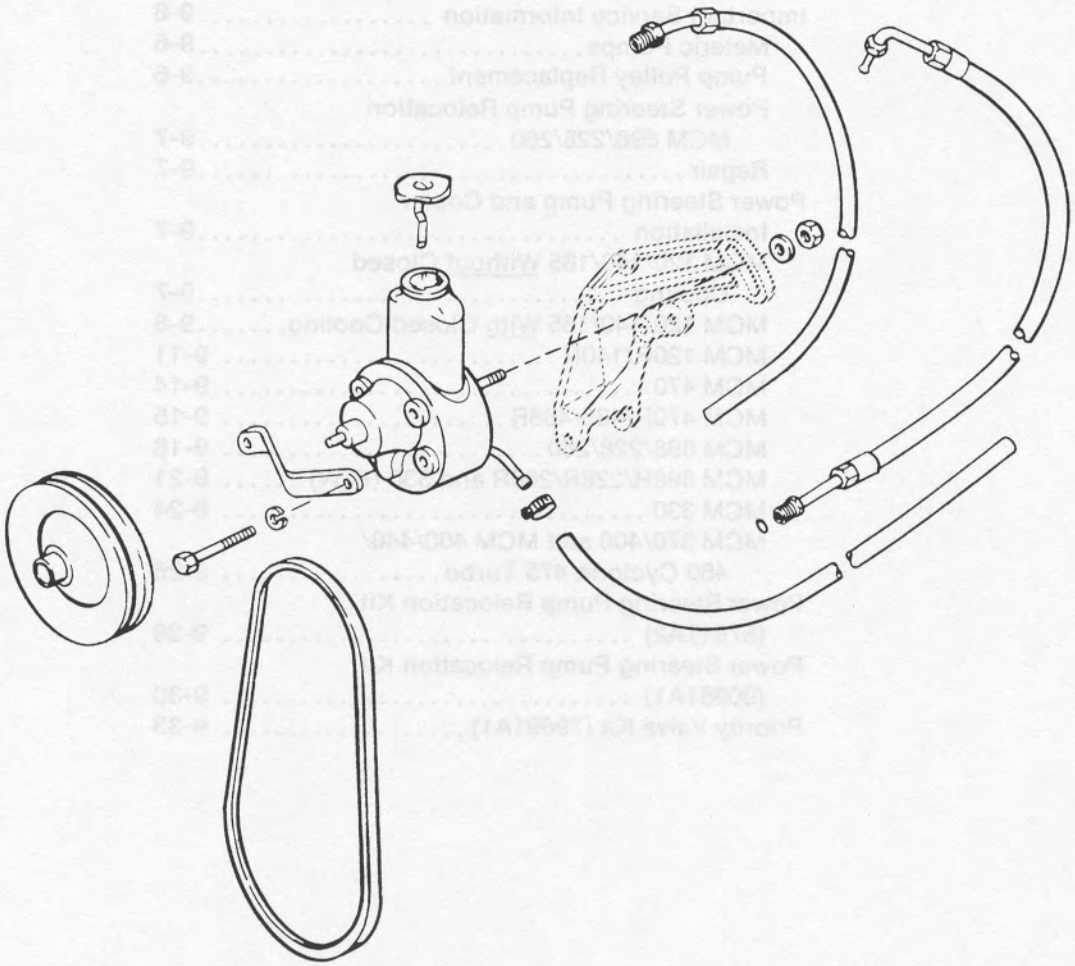


18490

a - Strut
b - Cutlass Bearing

Figure 8. Strut

SECTION 9 - POWER STEERING



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STERN DRIVES & INBOARDS

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TORQUE SPECIFICATIONS

Fastener Location	120/140/165		470/485/488	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Crankshaft Pulley To Harmonic Balancer	20 (27)			
Harmonic Balancer To Crankshaft	60 (81)			
Pump Mounting Bracket To Engine	30 (41)		25 (34)	
Recirculation Pump Pulley		240 (27)		

Fastener Location	305/350 CID V-8 Engines		454 CID V-8 Engines	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft (N.m)	Lbs. In. (N.m)
Crankshaft Pulley To Harmonic Balancer	35 (42)		35 (42)	
Harmonic Balancer To Crankshaft	60 (81)		80 (109)	
Pump Mounting Bracket to Engine	30 (41)		30 (41)	
Recirculation Pump Pulley		240 (27)		240 (27)

TOOLS/SEALANTS

MERCURY MARINE SPECIAL TOOLS	
91-93656A1	Pulley Installer

KENT-MOORE SPECIAL TOOLS Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
J-25034	Pulley Removal Tool

SEALANTS	
92-34227	Quicksilver Perfect Seal

PRECAUTIONS

⚠WARNING

Be careful when working on fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure battery is DISCONNECTED. DO NOT smoke or allow sources of spark or flame in the area while servicing. Wipe up any spilled fuel immediately.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠WARNING

Always disconnect battery cables from battery BEFORE working on engine to prevent fire or explosion.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION

DO NOT pry on power steering pump or alternator when adjusting belt tension. Serious damage may result.

CHECKING FLUID LEVEL

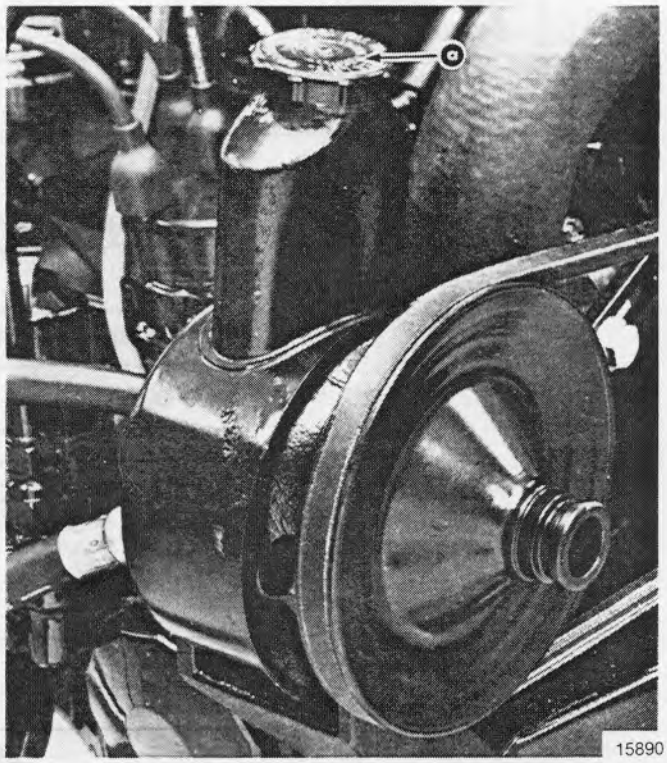
IMPORTANT: Use only automatic transmission fluid (ATF), Dexron or Dexron II in Power Steering System.

With Engine Cold

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level. (Figure 1)
3. Level should be between "FULL COLD" mark and bottom of dipstick. (Figure 2)
4. If fluid level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of automatic transmission fluid (ATF), thru fill cap opening, to bring level up to "FULL COLD" mark on dipstick. DO NOT OVERFILL.

With Engine Warm from Operation

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level. (Figure 1)
3. Level should be between the "FULL HOT" mark and "ADD" mark on dipstick. (Figure 2)
4. If level is low (below "ADD" mark), but fluid is still visible in pump reservoir, add required amount of automatic transmission fluid (ATF), thru fill cap opening, to bring level up to "FULL HOT" mark on dipstick. DO NOT OVERFILL.



a - Fill Cap/Dipstick

Figure 1. Checking Fluid Level

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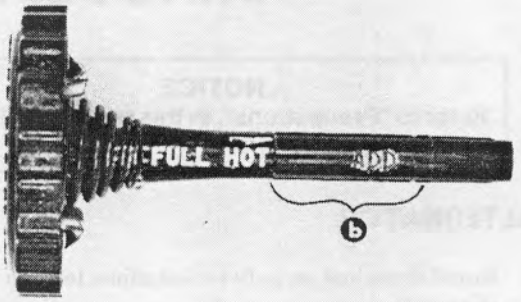

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a - Engine Cold
b - Engine Warm

Figure 2. Fill Cap/Dipstick

FILLING and BLEEDING SYSTEM

IMPORTANT: Power Steering system MUST BE filled exactly as explained, following, to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering system to become spongy, which may result in poor boat control.

1. Position drive unit so that it is straight back. Check fluid level with dipstick attached to fill cap. Add automatic transmission fluid (ATF), as required, to bring level up to "Full-Cold" mark on dipstick.

IMPORTANT: Use only automatic transmission fluid (ATF), Dexron or Dexron II in Power Steering System.

2. Turn steering wheel back-and-forth to end of travel in each direction several times; then recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back-and-forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse, then check fluid level and add fluid, as required, to bring level up to "Full-Hot" mark on dipstick. DO NOT OVERFILL. Reinstall fill cap securely.

IMPORTANT: Drive unit MUST BE positioned straight back and Power Steering fluid MUST BE hot to accurately check fluid level.

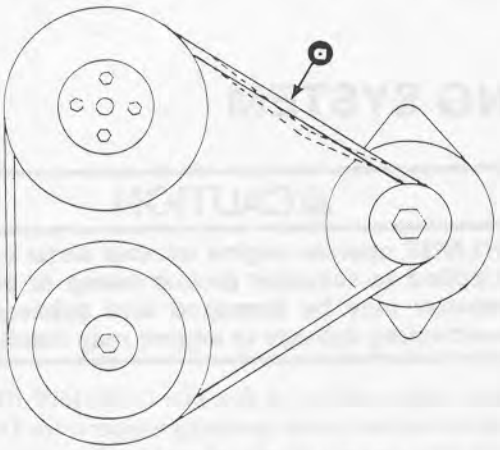
6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

DRIVE BELT TENSION ADJUSTMENT

NOTICE
Refer to "Precautions", in this section BEFORE proceeding.

ALTERNATOR

1. Install drive belt on pulleys and adjust tension as follows. (Figure 1)
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown in Figure 1.
   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolts.



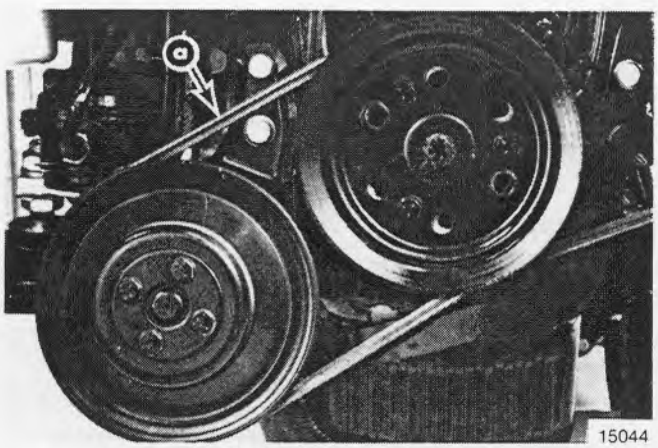
a - Belt Should Depress 1/2" (13mm)

Figure 1. Alternator Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

SEAWATER PICKUP PUMP

1. Install drive belt on pulleys and adjust tension as follows. (Figure 2)
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown in Figure 2.
   b. After obtaining correct tension, securely retighten pump brace and pump mounting bolts.



a - Belt Should Depress 1/4" (6mm)

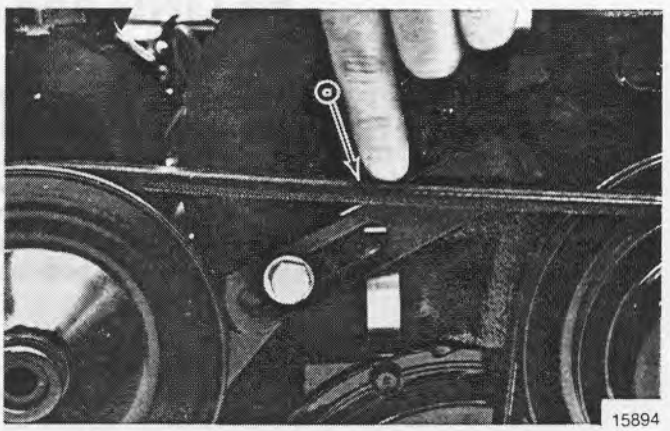
Figure 2. Seawater Pump Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

POWER STEERING PUMP

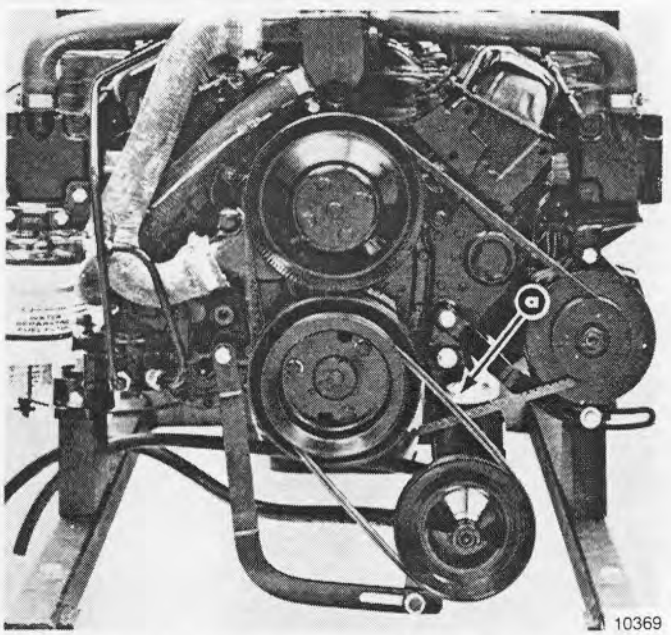
IMPORTANT: DO NOT pry on pump with pry bar or screwdriver.

1. Install drive belt on pulleys and adjust tension as follows. (Figures 3, 4, 5, 6, 7 or 8)
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown.
   b. After obtaining correct tension, securely retighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.



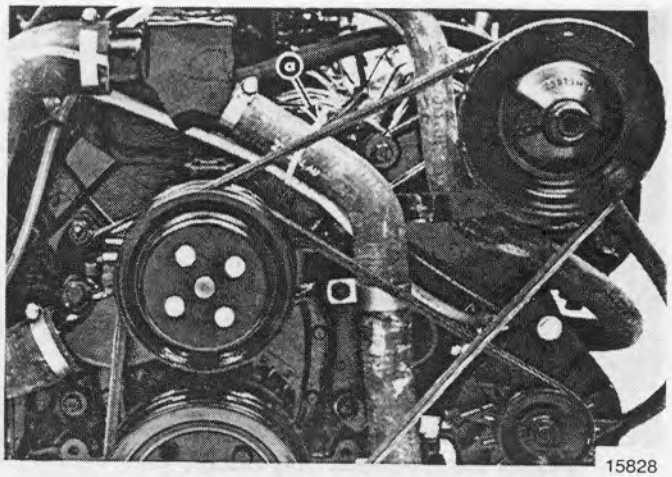
a - Belt Should Depress 1/4" (6mm)

Figure 3. MCM 120/140/165



a - Belt Should Depress 1/4" (6mm)

Figure 4. MCM 898/228/260/330 With Low Mounted Pump



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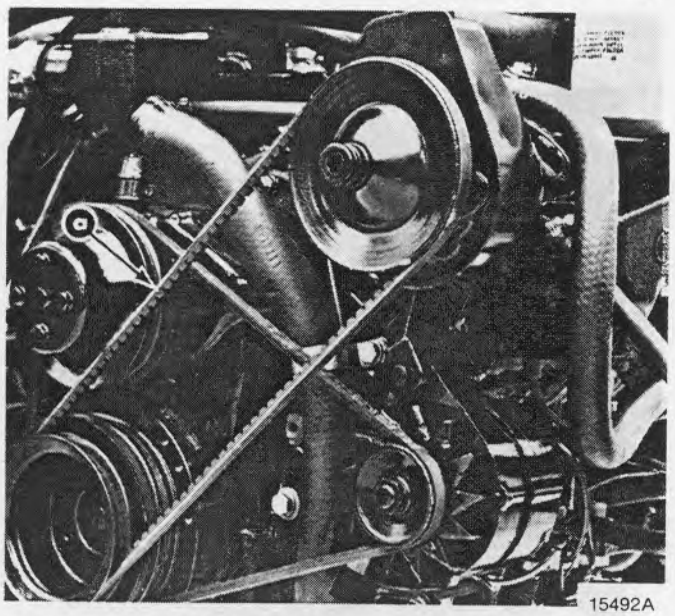
a - Belt Should Depress 1/4" (6mm)

Figure 5. MCM 898/228/260 With High Mounted Pump



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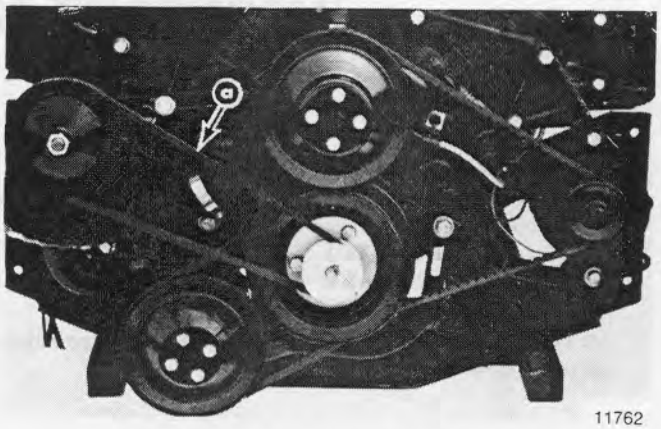
a - Belt Should Depress 1/2" (13mm)

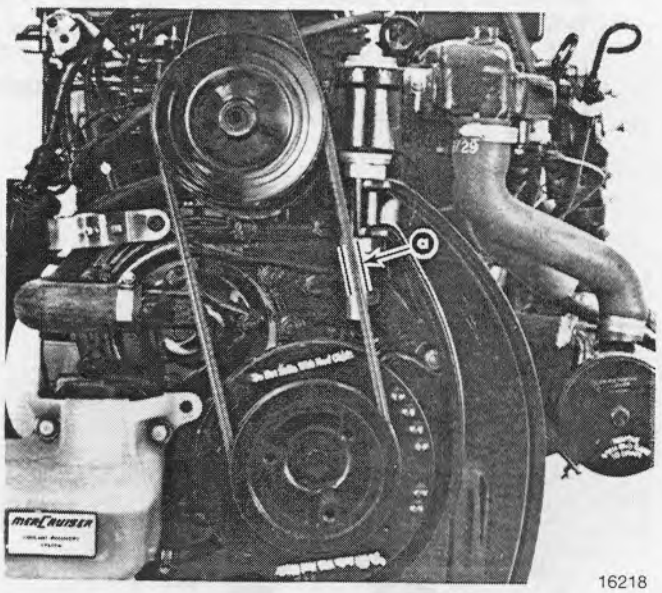
Figure 6. MCM 330 (B-W)



11762

a - Belt Should Depress 1/4" (6mm)

Figure 7. Hi-Performance Power Steering Models



16218

a - Belt Should Depress 1/4" (6mm)

Figure 8. MCM 470/485/488

IMPORTANT SERVICE INFORMATION

METRIC PUMPS

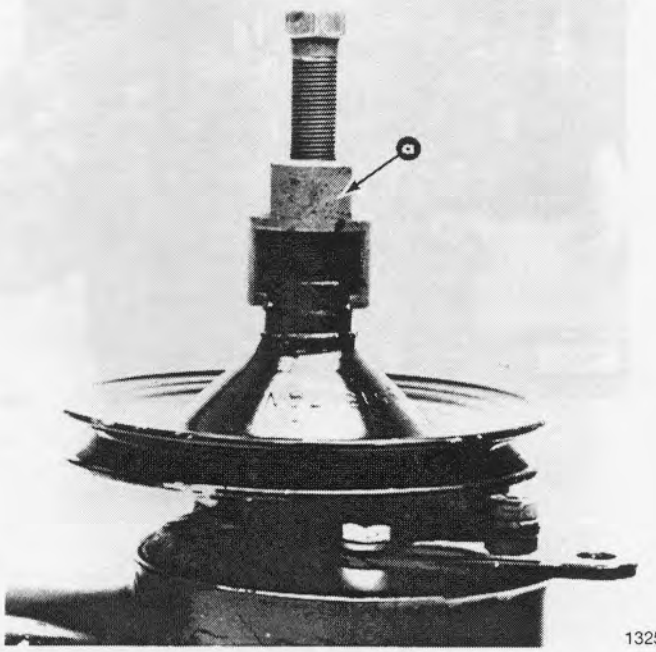
Later model power steering pumps are metric, all hose fittings, and attaching hardware are also metric, listed below are the metric mounting studs for MCM engines:

MCM 120/140	16-41877
All MCM V-8's	16-41877
MCM 470/485/488	16-41878

An O-ring is used to seal the metric power steering pump pressure hose. P.N. 25-89879.

PUMP PULLEY REPLACEMENT

1. Kent-Moore Tool (J-25034) must be used to remove the pressed on pulleys used on power steering pumps. (Figure 1) This tool has an end on it that will not mushroom the end of the pump shaft. DO NOT use Kent-Moore Tool (J-21239) to remove these pulleys. This tool has a tapered end and will damage the shaft.



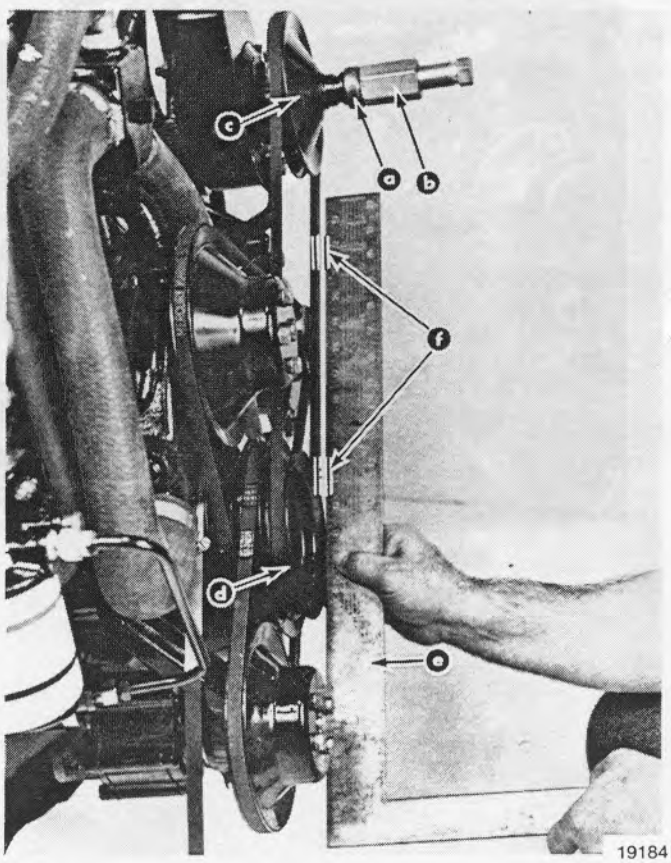
a - Pulley Removal Tool

Figure 1. Removing Pulley

2. The Pulley Pusher Tool (91-93656A1) is used to install pulleys on Power Steering pumps for MerCruiser In-Line and V-8 Engines. To install pulley, using Pusher Tool, proceed as follows:
   a. Place pulley on pump shaft.
   b. Place ball bearing on Pulley Pusher Tool. DO NOT use spacer stamped with "135" and "200".
   c. Thread Pulley Pusher Shaft all-the-way into pump shaft.

IMPORTANT: Pusher Shaft MUST BE threaded all-the-way into pump shaft or damage to pump/ pusher shaft threads may occur.

   d. Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parrallel to straight edge. (Figure 2) Check pulley installation for correct belt alignment.



a - Ball Bearing
b - Pulley Pusher
—91-93656A1
c - Pump Pulley
d - Crankshaft Pulley (Shown) or Circulating Pump Pulley
e - Long Straight Edge
f - Drive Belt Parallel

Figure 2. Installing Pulley

POWER STEERING PUMP RELOCATION MCM 898/228/260

IMPORTANT: MCM 898R/228R/260R Models do not require this kit.

Stern drive engines listed below have the "Hi-Mounted" power steering pump:

MCM 898	5820293 - 6218461
MCM 228	5842150 - 6225266
MCM 260	5818850 - 6227756

When a Closed Cooling System is installed on these engines, the Power Steering Pump must be relocated. Power Steering Pump Mounting Kit (57611A2) allows the pump to be moved to the low-mounted location. (Figure 3)

REPAIR

Pressure checks and cylinder repairs are covered in appropriate "Stern Drive Service Manual".

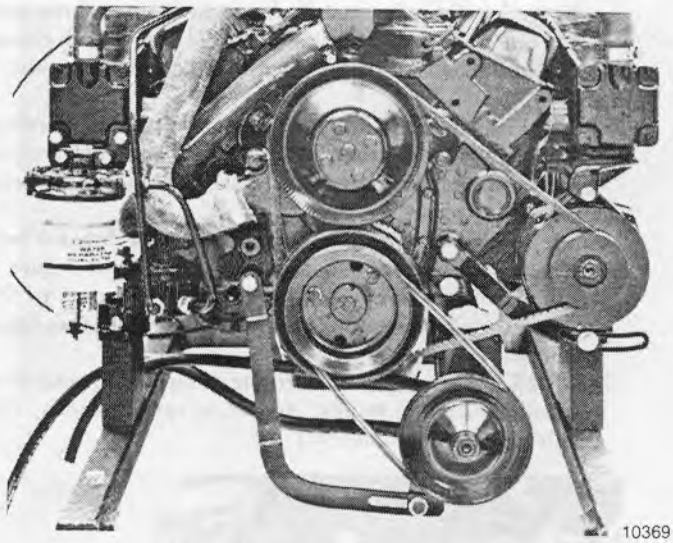
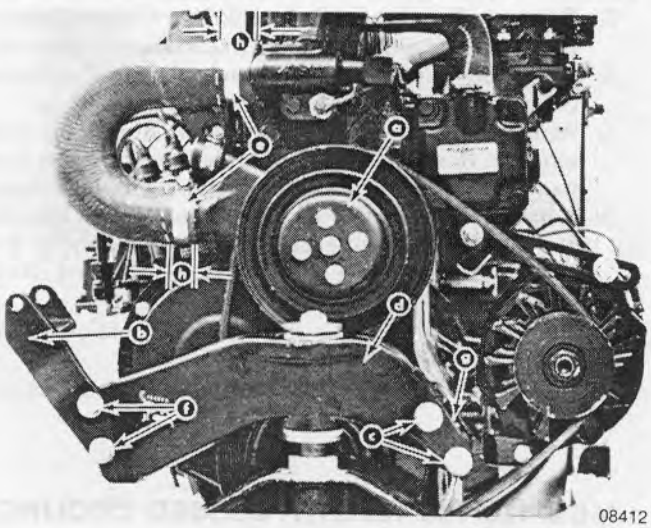


Figure 3. Pump Mounting Kit Installed

POWER STEERING PUMP MOUNTING and COOLER INSTALLATION

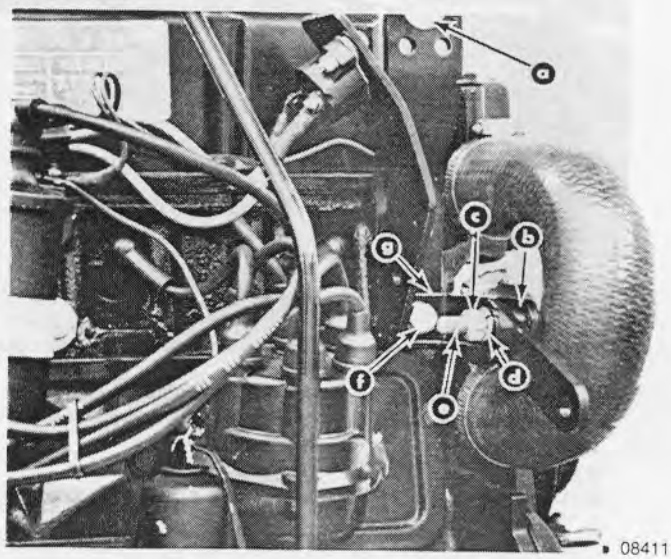
MCM 120/140/165 WITHOUT CLOSED COOLING

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.



a - Pulley (3 Groove)
b - Power Steering Pump Mount
c - Engine Mount Bolts
d - Engine Mount
e - Hose Clamps
f - Engine Mount Bolts
g - Engine Mount Spacer
h - Remove 1" (25mm) From Standard Hose if New Hose is Being Installed

Figure 1. Installing Components

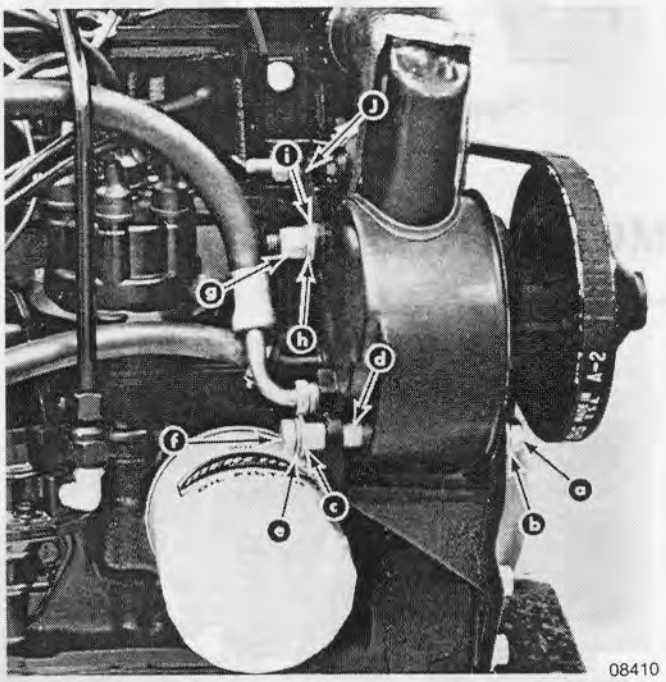


a - Front Lifting Eye
b - Spacer
c - Nut
d - Lockwasher
e - Lower Lifting Eye Attaching Bolt
f - 90° Bracket

Figure 2. Power Steering Pump Brace

1. Install pump pulley with bolts and washers. Tighten securely. (Figure 1)
2. Install V-Belt on pump pulley, alternator pulley, and crankshaft pulley. Adjust tension to specifications.
3. Install Power Steering pump mount to engine mount (Figure 1). Secure with 2¾" (70mm) long bolts, using washers and lockwashers.
4. Install engine mount spacer and bolts, washers and lockwashers. Tighten securely.

5. If new hose is being installed, cut 1" (25mm) from each end of standard hose. Install hose and secure with clamps so that clearance is provided after Power Steering pump is installed.
6. Remove lower front lifting eye to cylinder head attaching bolt and retain lockwasher. Position 90° bracket over the lift eye and secure with 1¼" (32mm) long bolt using retained lockwasher. (Figure 2)
7. Install Power Steering pump to mounting bracket with bolts, spacer, washers and nuts, as shown in Figure 3. Attach Power Steering pump adjusting bracket to 90° bracket with carriage bolt, spacer, lockwasher and nut. (Figure 2)
8. Install V-Belt on Power Steering pump pulley and water circulation pump pulley. Adjust to specifications. (See "Drive Belt Adjustments")

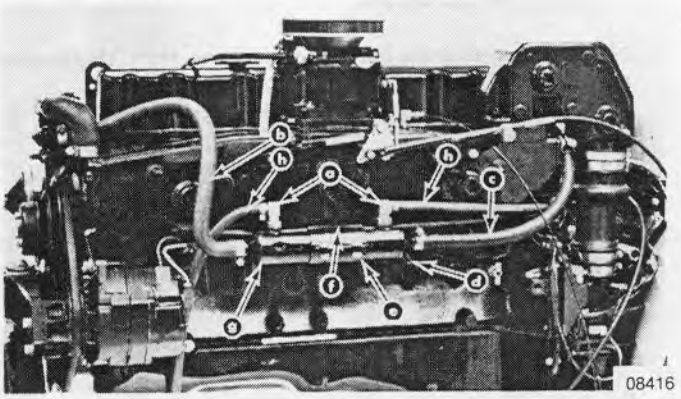


a - 1" (25mm) Long Bolt
b - Lockwasher
c - Flatwasher
d - Bushing
e - Lockwasher
f - 1-1/4" (32mm) Long Bolt
g - Pump Adjustment Nut
h - Lockwasher
i - Flatwasher
j - Pump Adjustment Bracket

Figure 3. Power Steering Pump Installed

Installing Fluid Cooler

1. Position oil cooler mounting brackets to oil cooler and install two ¾" (19mm) long bolts and nuts. DO NOT tighten at this time.
2. Position oil cooler mounting brackets to bottom of manifold (for 120 and 165 models, use mounting bracket holes nearest cooler; for 140 model, use holes furthest from cooler). Secure brackets with 2 bolts and lockwashers. Drain plug in fluid cooler must be positioned toward rear of engine. (Figure 4)
3. Install straight hose to rear of fluid cooler and secure with hose clamp. Route hose under exhaust elbow and attach to upper outside end cap bolt of manifold with clip. (Figure 4)
4. Install hose to water tube at gimbal housing. Secure hose with hose clamp.
5. Install 90° end of hose to front of fluid cooler and secure with hose clamp. (Figure 4)
6. Install hose to water distribution housing. Secure hose with clamp.



a - 90° Elbows
b - Outlet Water Hose
c - Inlet Water Hose
d - Drain Plug
e - Fluid Cooler Mounts
f - Mounting Bolts
g - Fluid Cooler
h - Power Steering Hose

Figure 4. Fluid Cooler Installed

Installing Fluid Hoses

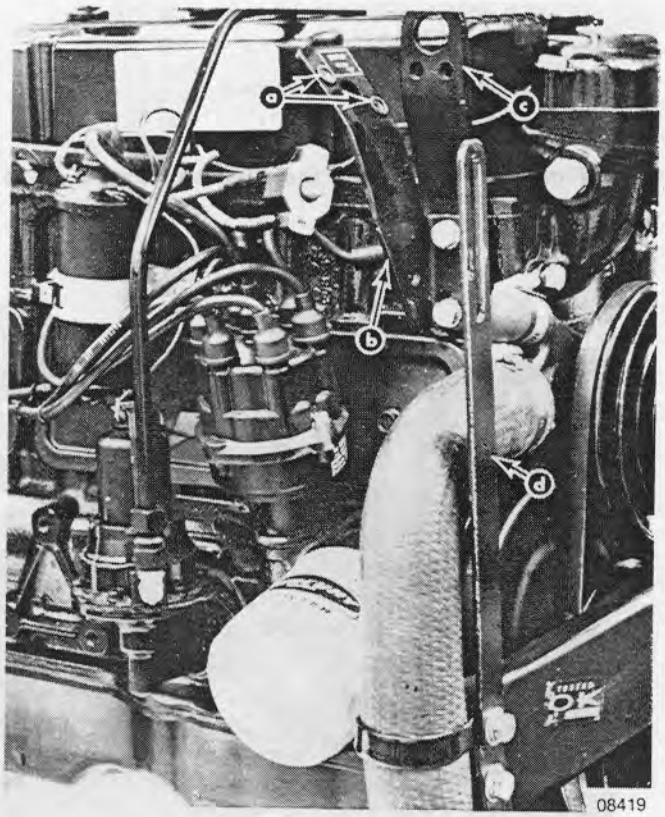
1. Install 90° elbows to fluid cooler as shown in Figure 4. Coat threads of elbow with Perfect Seal before installation.
2. Remove all shipping caps from Power Steering pump and Power Steering cylinder prior to installation of hoses.
3. Install pressure hose to pump and cylinder. Position hose to ensure clearance and prevent hose damage.
4. Attach fluid return hose to cylinder. Route hose to rear elbow of fluid cooler. (Figure 4) Cut hose to proper length, install hose and secure to fluid cooler with hose clamp.
5. Attach plain hose to front of fluid cooler with hose clamp from kit. Route hose under engine and up to Power Steering pump. Cut hose to proper length and attach to pump. Secure hose with hose clamp.
6. Tighten bolts and nuts (Figure 4) to hold oil cooler in position shown in Figure 4.
7. Follow "Filling and Bleeding System" proceedures in this section.

MCM 120/140/165 WITH CLOSED COOLING SYSTEM

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

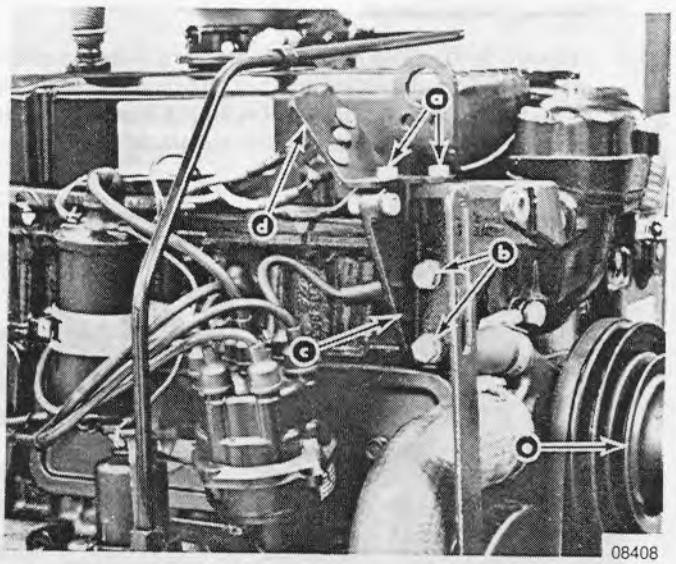
1. Install pump adjustment bracket (slotted end up) with 2½" (64mm) long bolt, and washers. (Figure 1)
2. Install Power Steering pump mounting bracket over lifting eye and secure with two 1½" (38mm) long bolts and washers. (Figure 2)

3. Install circuit breaker mount to Power Steering mount with two ½" (13mm) long bolts and lockwashers. (Figure 2)
4. Install rubber washers and spacers to mount. Secure circuit breaker with screws and nuts, as shown in Figure 1.
5. Install Power Steering pump to mounting bracket with bolts, washers and bushing, as shown in Figure 3.
6. Attach adjustment brace to pump with bolt, spacer and washers, as shown in Figure 3.
7. Position pulley on water circulating pump and secure with bolts and washers. Tighten securely.
8. Install alternator drive belt over crankshaft, circulating pump and alternator pulleys. Install spacer and secure mount with bolts. Tighten securely.
9. Adjust alternator drive belt tension to specifications. (See "Drive Belt Adjustments")



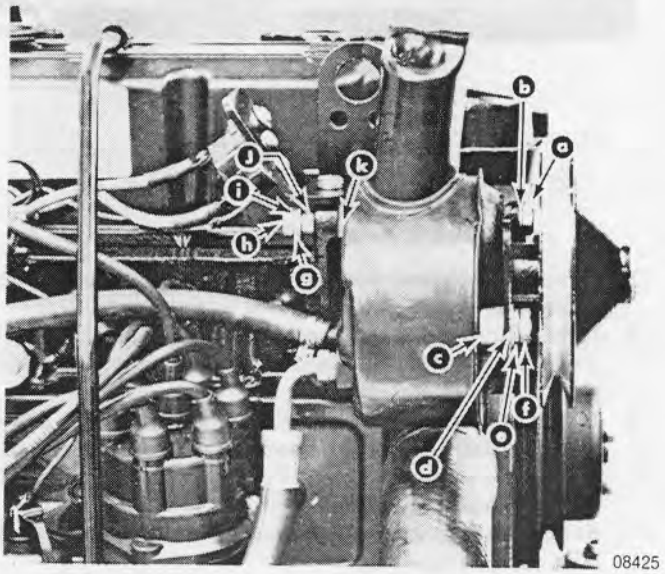
a - Rubber Washers and Spacers
b - Circuit Breaker Mount
c - Lifting Eye
d - Pump Adjusting Bracket

Figure 1. Pump Adjusting Bracket Installed



a - 1/2" (13mm) Long Bolts
b - 1-1/2" (38mm) Long Bolts
c - Pump Mounting Bracket
d - Circuit Breaker Mount
e - Pulley (Circulation Pump)

Figure 2. Pump Mounting Bracket Installed

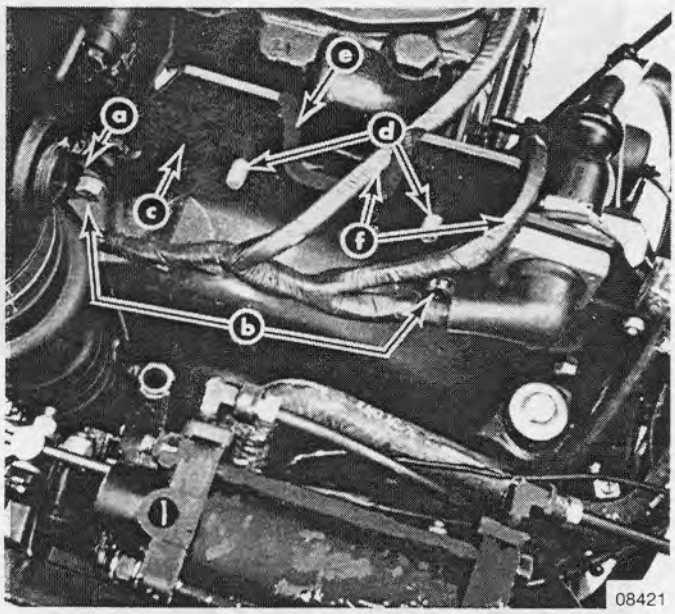


a - 1" (25mm) Long Bolt
b - Lockwasher
c - Spacer
d - Flatwasher
e - Lockwasher
f - 1-1/4" (32mm) Long Bolt
g - Lockwasher
h - 1-1/2" (38mm) Long Bolt
i - Flatwasher
j - Bushing
k - Flatwasher

Figure 3. Pump Installed on Mounting Bracket

Installing Fluid Cooler

1. Position 2, ¾" (19mm) long bolts thru holes in adaptor plate (head of bolt toward engine) and install adaptor plate as shown in Figure 4. Position insulator over adaptor plate and route wiring harness over insulator, as shown in Figure 4.



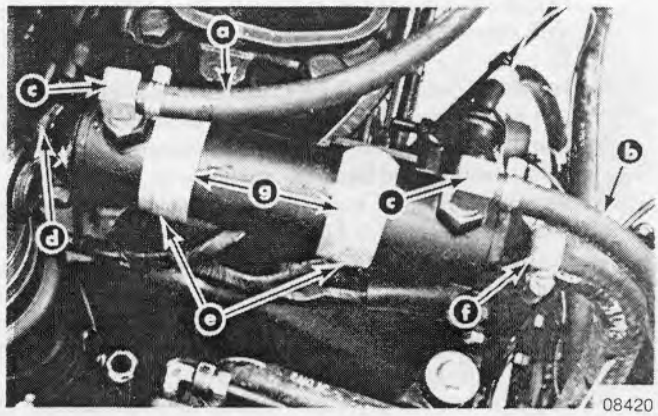
a - Lifting Eye
b - Bell Housing Bolts
c - Adaptor Plate
d - 3/4" (19mm) Long Bolts
e - Insulator
f - Routing Harness

Figure 4. Adaptor Plate Installed

2. Install straight hose to left end of fluid cooler (end without drain plug) and secure with hose clamp.
3. Install fluid cooler to adaptor plate with brackets, lockwashers and nuts, as shown in Figure 5. Drain plug must be toward right side of engine.
4. Install molded hose to water tube and secure with hose clamp. Install other end of hose to right side of fluid cooler and secure with hose clamp. Position hose to allow clearance for Power Steering.
5. Route straight hose to heat exchanger and secure with hose clamp. (Figure 6)

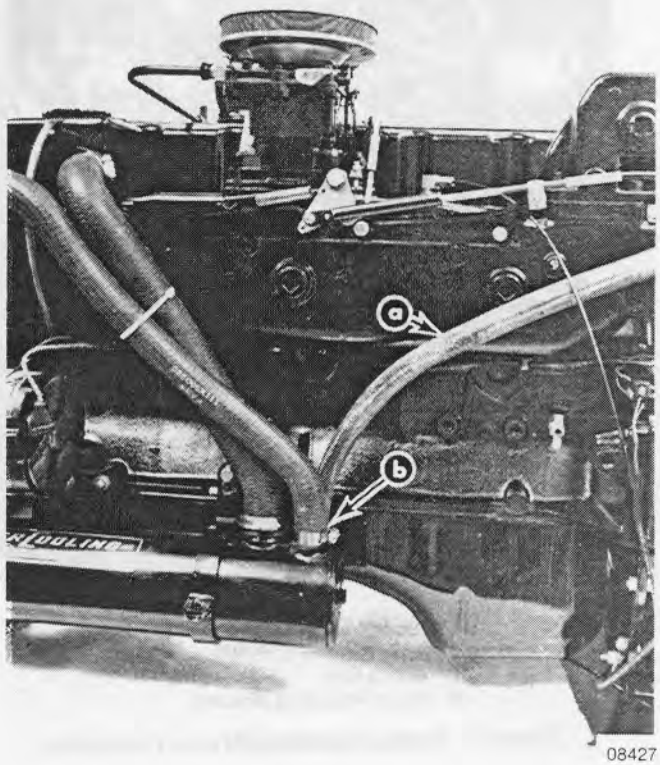
Fluid Hose Installation

1. Coat threads of 90° elbow with Perfect Seal before installing elbows. Install elbows as shown in Figure 5.
2. Install pressure hose to pump and cylinder. Position hose to ensure clearance and prevent hose damage.
3. Attach fluid return hose to cylinder. Route hose to right elbow of fluid cooler. (Figure 5) Install hose and secure with hose clamp.
4. Attach fluid hose to left elbow of fluid cooler with hose clamp. Route hose to Power Steering pump. Attach hose to pump and secure with hose clamp.



a - Hydraulic Hose to Power Steering Pump
b - Hydraulic Hose to Power Steering Cylinder
c - 90° Elbows
d - Water Outlet
e - Nuts and Washers (Hidden)
f - Water Inlet
g - Brackets

Figure 5. Fluid Cooler Installed on Adaptor Plate



a - Hose from Fluid Cooler
b - Clamp (Hidden)

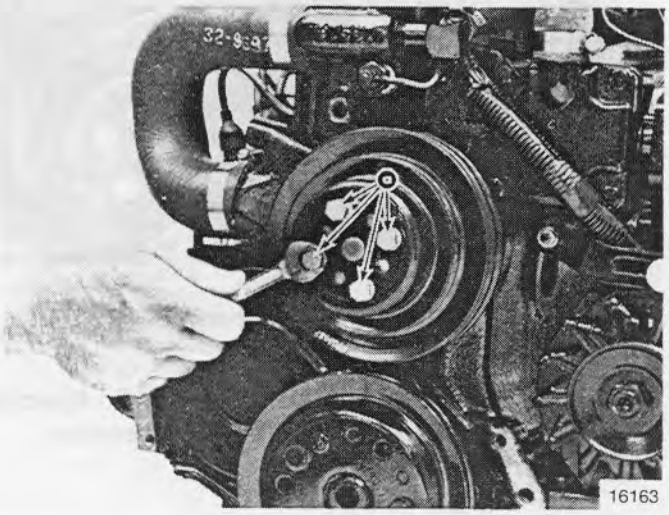
Figure 6. Hose to Heat Exchanger Secured

5. Follow "Filling and Bleeding System" procedures in this section.

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

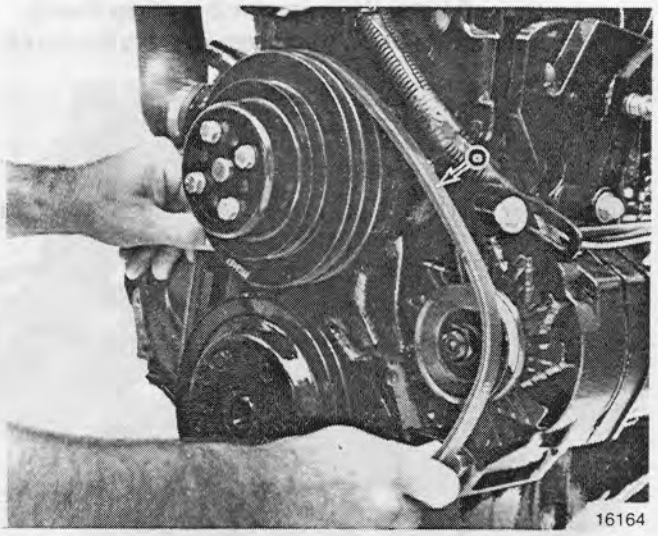
STEP 1 Install Pulley

STEP 2 Install Attaching Screws and Tighten Securely



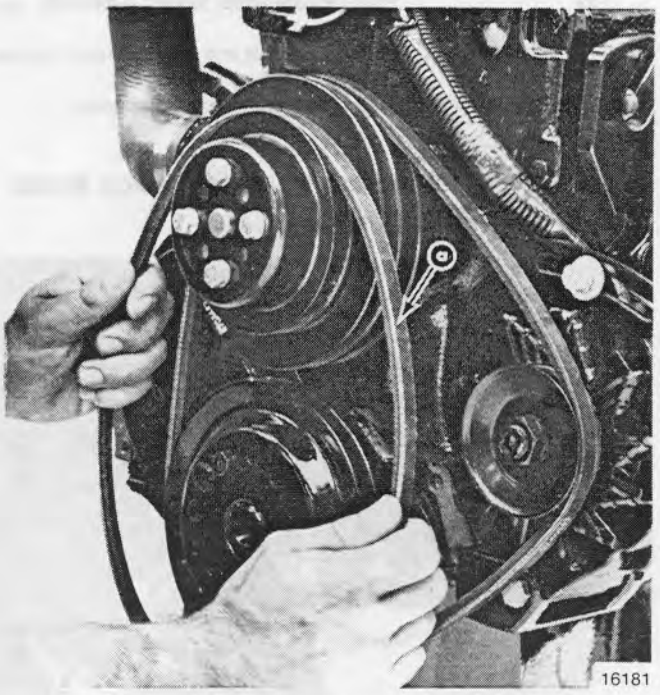
a - Bolts and Lockwashers

STEP 3 Install 40" (1016mm) Drive Belt



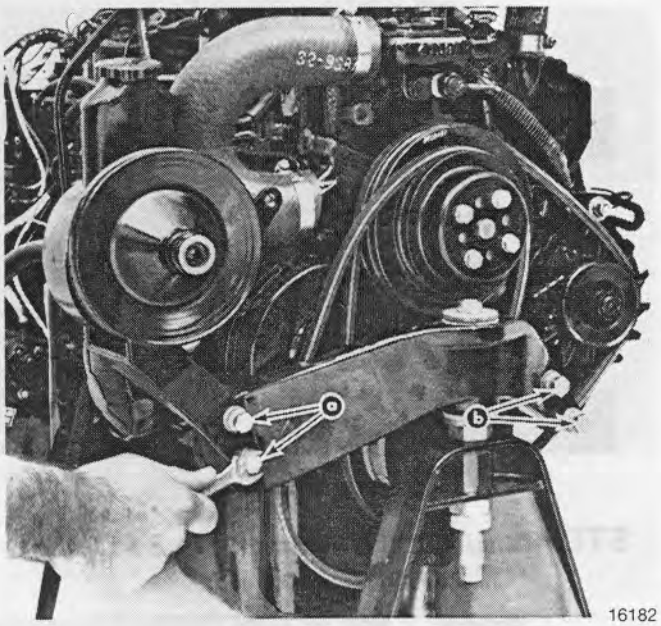
a - 40" (1016mm) Drive Belt

STEP 4 Install 37" (940mm) Drive Belt Over Circulating Pump Pulley



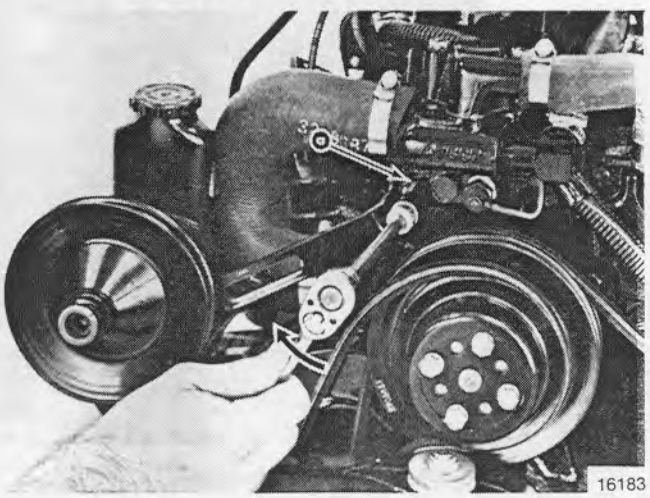
a - 37" (940mm) Drive Belt

STEP 5 Install Front Mount Assembly Along With Power Steering Pump Assembly. Tighten Screws Securely



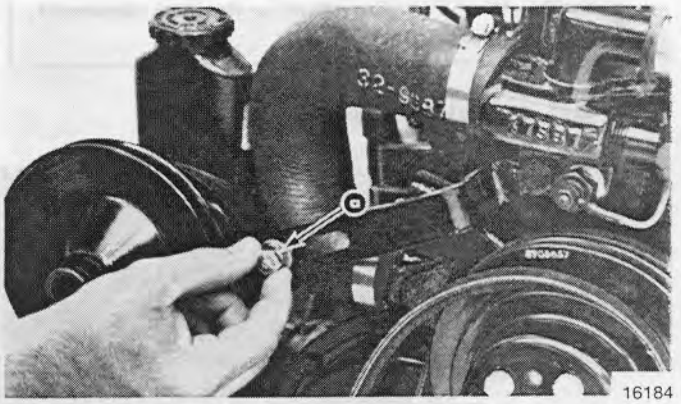
a - 2-3/4" (70mm) Long Bolts, Washer and Lockwashers (Tighten Securely)
b - Bolts, Washers, and Lockwashers (Tighten Securely)

STEP 6 Attach Power Steering Pump Brace to Engine



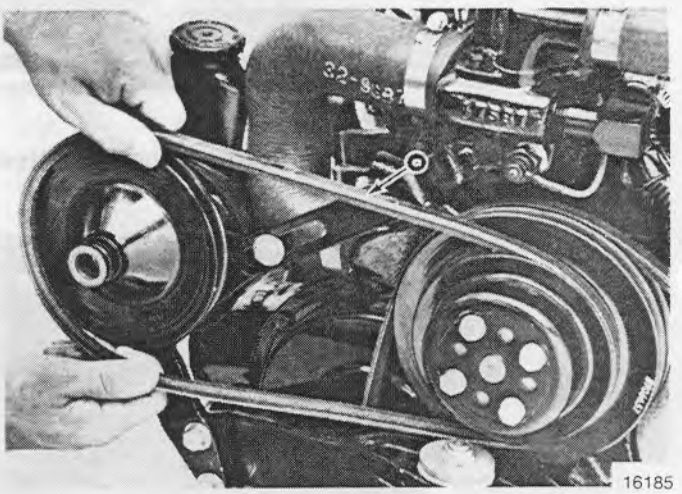
a - 1-1/4" (32mm) Long Bolt Without Closed Cooling. 1-1/2" (38mm) Long Bolt With Closed Cooling.

STEP 7 Attach Power Steering Pump Brace to Pump



a - 7/8" (22mm) Long Bolt and Washer

STEP 8 Install 37" (940mm) Drive Belt Over Pump Pulley

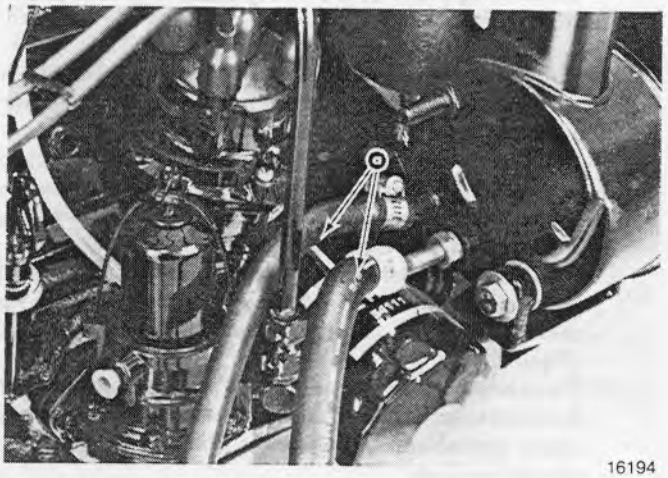


a - 37" (940mm) Drive Belt

STEP 9 Adjust Drive Belt Tension To Specifi cations. See "Drive Belt Tension Adjustment"

IMPORTANT: DO NOT pry against side of pump, as damage may result.

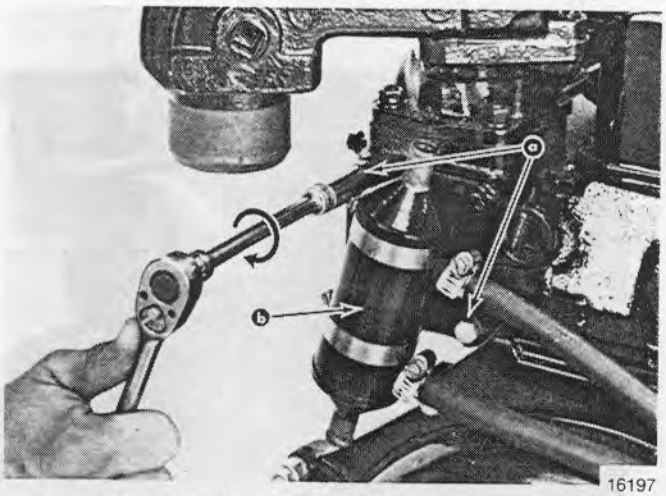
STEP 10 Route Hydraulic Hoses



16194

a - Hydraulic Hose Routing

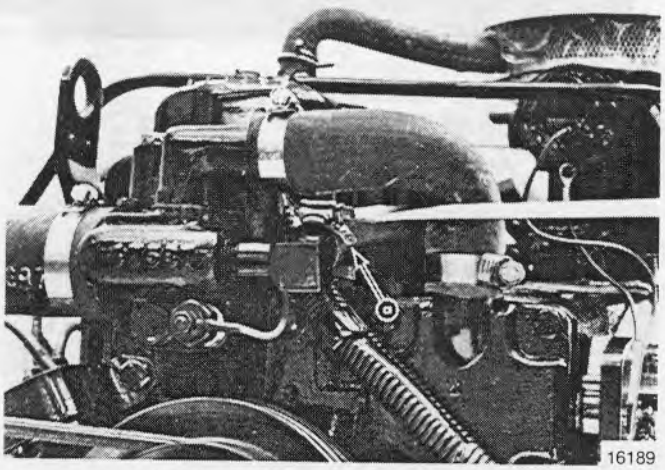
STEP 11 Install Fluid Cooler and Tighten Screws Securely



16197

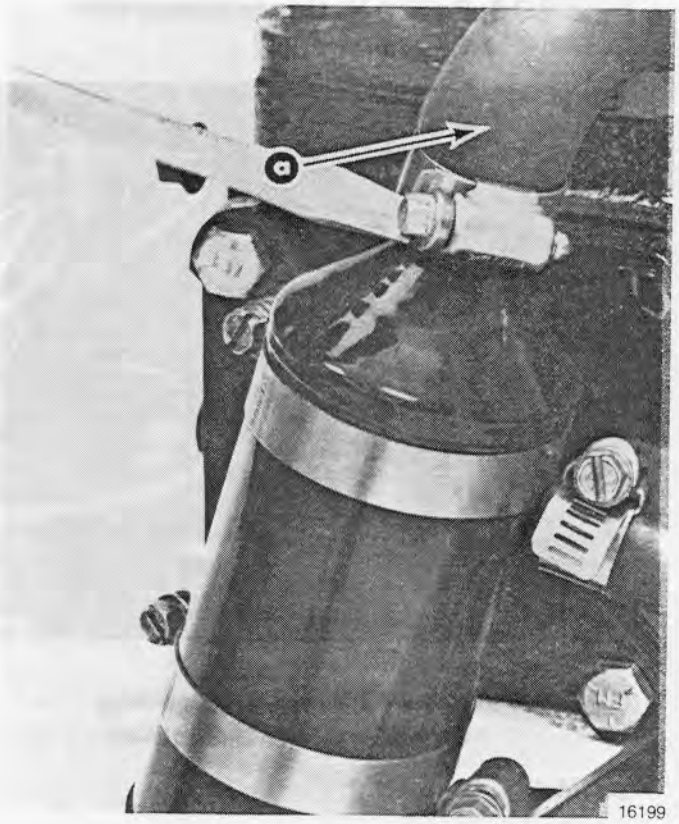
a - Install 1" (25mm) Long Bolts. Tighten Securely
b - Fluid Cooler

STEP 12 Install Long Water Hose And Tighten Clamps Securely



16189

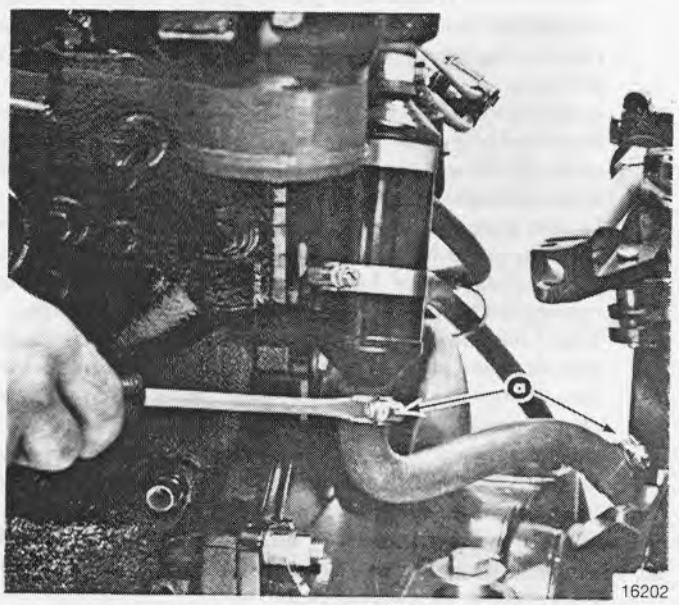
a - Installing Engine End of 24" (610mm) Water Hose.



16199

a - Installing Cooler End of 24" (610mm) Water Hose

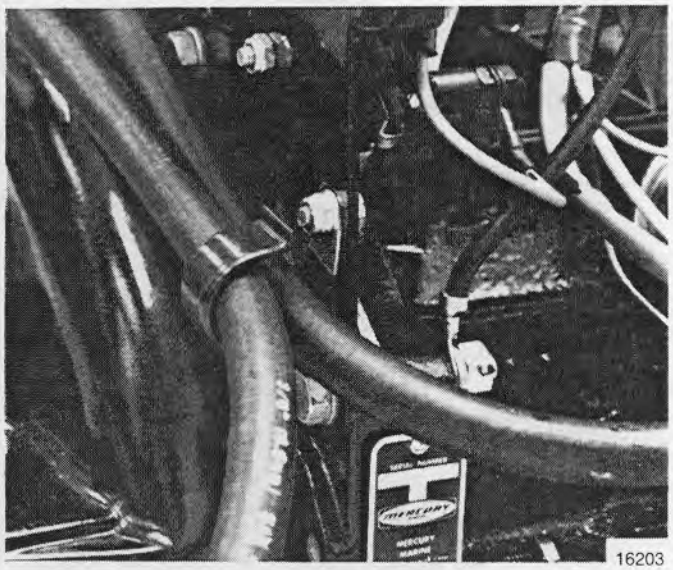
STEP 13 Install Short Water Hose And Tighten Clamps Securely



16202

a - Install Short Hose

STEP 14 Secure Hydraulic Hoses With J-Clamp



STEP 15 Follow Filling and Bleeding Procedures in This Section.

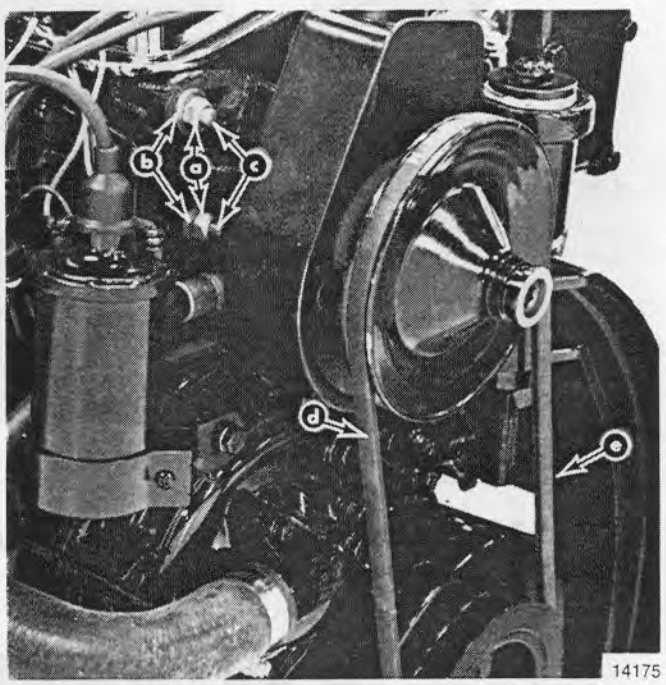
MCM 470

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove paint from Power Steering pump monting surface on front of cylinder head. Check for any burrs, etc, and remove if present. Mounting surface MUST BE smooth and clean.
2. Install two 1⅝" (41mm) long studs into threaded holes on front end of cylinder head. (Figure 1) Be sure to thread studs all-the-way into cylinder head so that shoulder on studs bottoms-out on head.
3. Loosen hose clamp and disconnect fluid cooler to Power Steering pump hose from bayonet connection on back of pump. Plug end of hose and hold pump with bayonet connection upward to prevent fluid from leaking out.
4. Route hose in behind 2 hoses on front end of exhaust manifold and up to Power Steering pump mounting location, then reconnect hose to pump, being sure to tighten clamp securely.
5. Position Power Steering pump and mounting bracket assembly in front of studs and place drive belt on pump pulley and on alternator rotor pulley. Install pump and mounting bracket assembly on studs and secure with ⅛" (3mm) thick flat washers and ⅜" - 24 nuts, (Figure 1) DO NOT tighten nuts at this time.
6. Adjust drive belt tension to specifications. (See "Belt Tension Adjustment".) Torque ⅜" x 24 nuts to specifications.

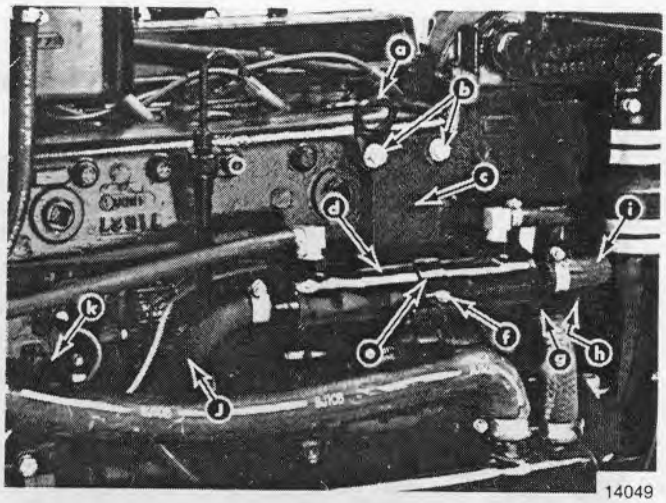
IMPORTANT: Retorque Power Steering pump and mounting bracket assembly attaching nuts after fist 20 hours of operation

7. Install ignition coil and mounting bracket assembly with wires running over the top of hydraulic hose. (Figure 1) Tighten securely.
8. Attach Power Steering fluid cooler mounting bracket and lifting eye to exhaust manifold, using two 6" (150mm) long bolts, lockwashers and 1/16" (2mm) thick flat washers. (Figure 2) Tighten Securely.
9. Position fluid cooler on mounting bracket with drain plug pointing downward. Install cooler retaining bracket and secure with ¾" (19mm) long screw and lockwasher. (Figure 2)
10. Place hose clamps over ends of "S" shaped hose and install hose between front end of Power Steering fluid cooler and water cooled voltage regulator. (Figure 2) Tighten hose clamps securely.
11. Place hose clamp over short end of "L"-shaped hose and connect hose to aft end of Power Steering fluid cooler. (Figure 2) Tighten clamp securely.
12. Place hose clamp over unattached end of "L"-shaped hose and connect hose to water pickup tube on gimbal housing. (Figure 2) Tighten clamp securely.



a - Nuts (3/8" - 24)
b - Flat Washers 1/8" (3mm) Thick
c - Studs 1-5/8" (41mm) Long
d - Drive Belt
e - Drive Belt Tension Check Point

Figure 1. Power Steering Pump Installed



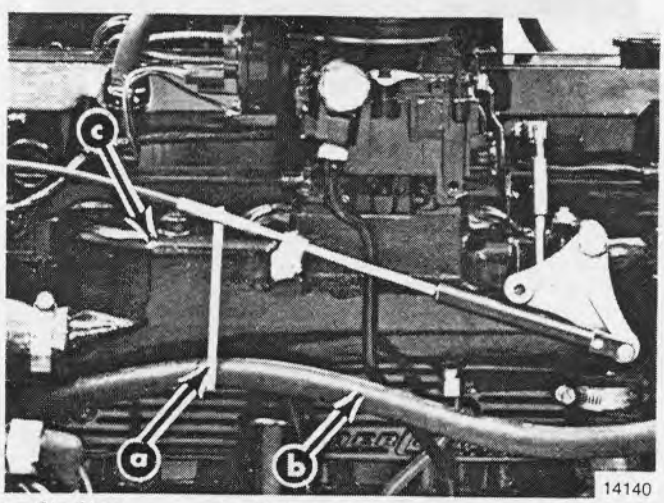
14049

a - Lifting Eye (Original)
b - Bolts 6" (150mm) Long Lockwashers and Flat Washers 1/16" Thick (2mm)
c - Fluid Cooler Mounting Bracket
d - Fluid Cooler
e - Fluid Cooler Retaining Bracket
f - Screw 3/4" (19mm) Long and Lockwasher
g - Drain Plug
h - Gimbal Housing Water Pickup Tube (Hidden)
i - "L"-Shaped Hose
j - "S"-Shaped Hose
k - Voltage Regulator

Figure 2. Power Steering Oil Cooler Installed

Hydraulic Hoses

1. Route pressure hose (attached to back of pump) along the bottom of intake manifold and back to Power Steering unit control valve.
2. Route fluid return hose (attached to aft elbow on fluid cooler) under exhaust elbow and over to Power Steering unit control valve. MAKE SURE THAT HOSE CLEARS STEERING SYSTEM MOVING PARTS.



14140

a - Sta-Strap b - Pressure Hose c - Intake Manifold

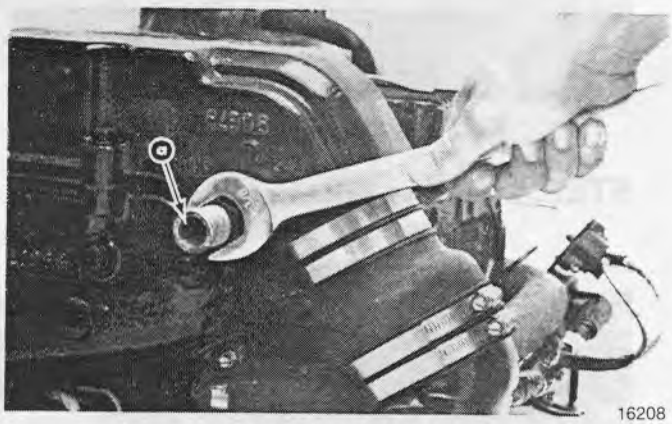
Figure 3. Power Steering Pressure Hose Secured to Intake Manifold

3. Fasten pressure hose to intake manifold (just aft of throttle cable brass barrel mounting boss) with sta-strap provided. (Figure 3)
4. Follow "Filling and Bleeding System" procedures in this section.

MCM 470R/485/488R

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

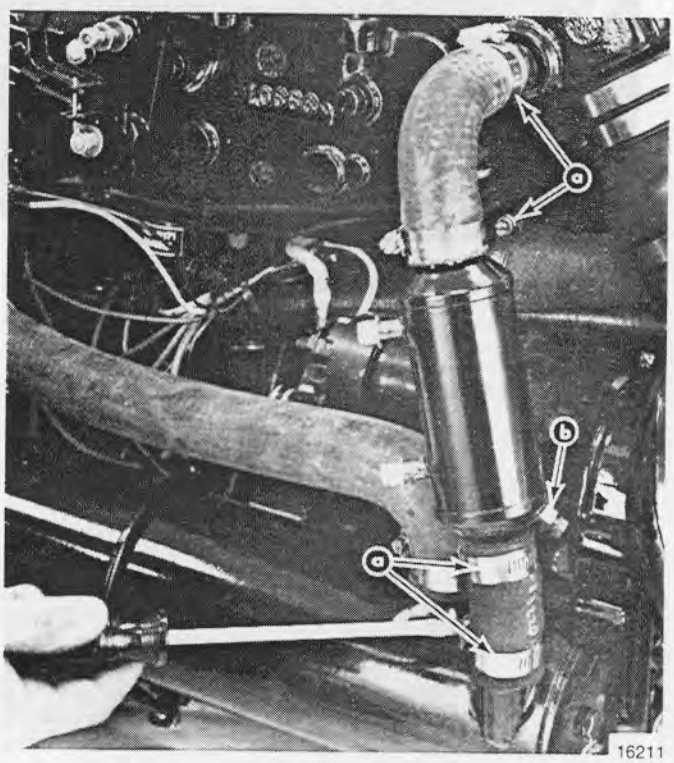
STEP 1 Apply Sealer to Hose Coupling and Install



16208

a - Straight Hose Coupling

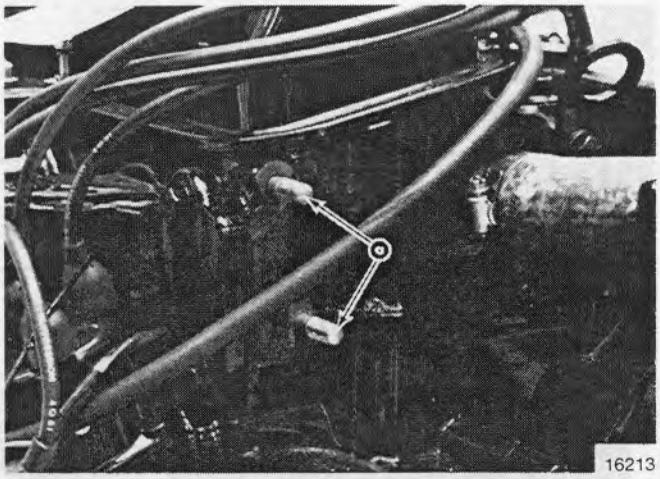
STEP 2 Install Fluid Cooler



16211

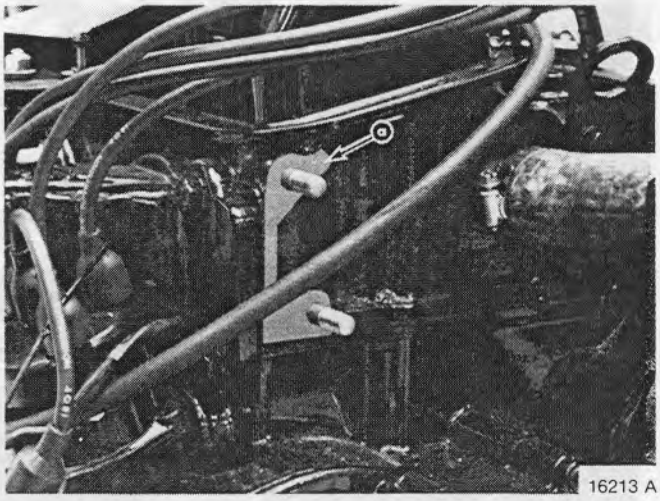
a - Hose Clamps - Tighten Securely
b - Cooler Drain Plug Must Face Down

STEP 3 Install Studs



a - 1-5/8" (41mm) Long Studs

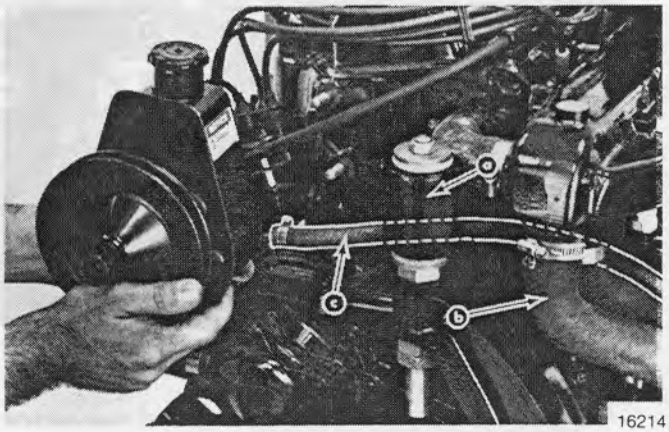
STEP 4 Remove Paint from Mounting Surface



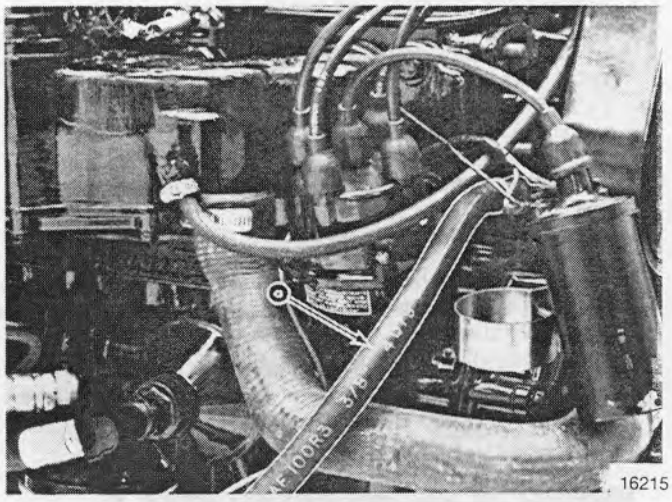
a - Remove All Paint (Making Surface is Smooth)

STEP 5 Route Hydraulic Hoses

IMPORTANT: Hydraulic Hose MUST BE Routed BEFORE Securing Pump.

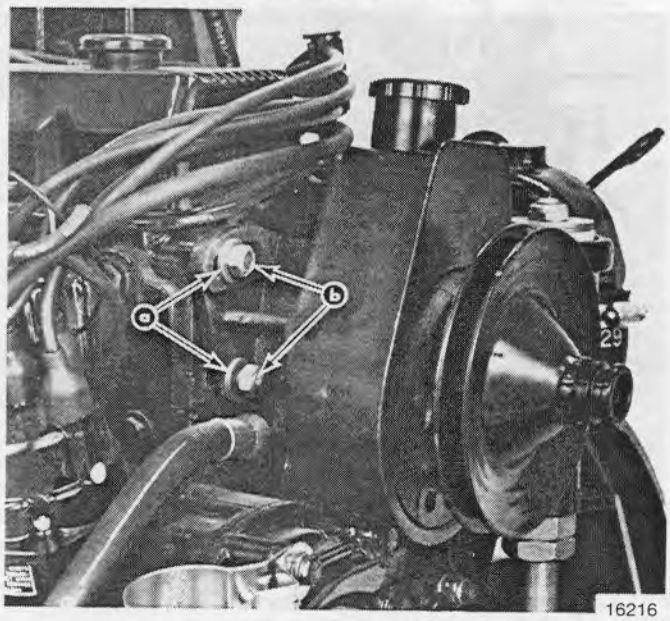


a - Motor Mount (Hose Routed Behind)
b - Exhaust Manifold Hose (Hose Routed Behind)
c - Hydraulic Hose



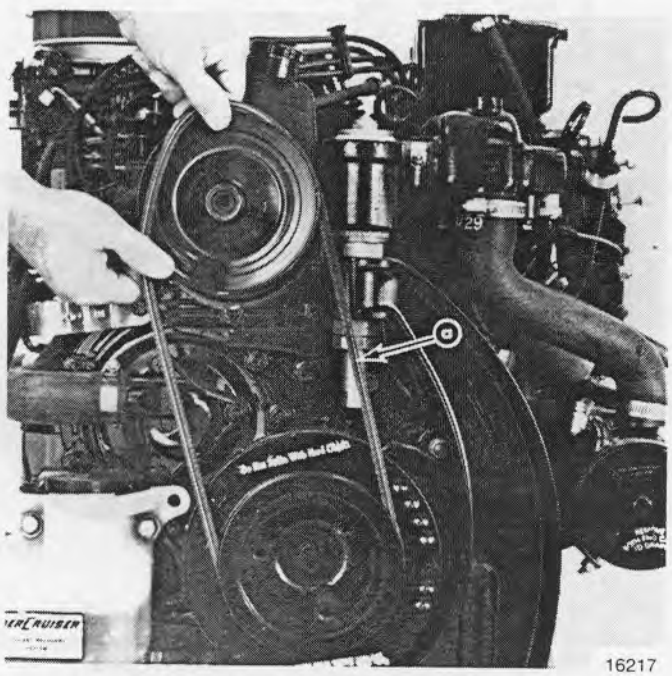
a - Hydraulic Hose Routed Between Distributor and Coil

STEP 6 Install and Fasten Pump



a - 1/8" (3mm) Thick Washers
b - 3/8" x 24 Nuts (Do Not Tighten At This Time)

STEP 7 Install Drive Belt



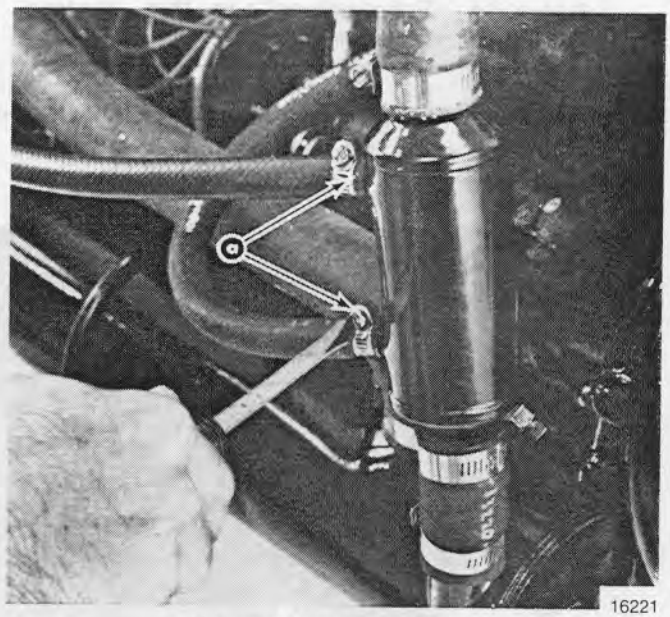
a - Drive Belt

STEP 8 Adjust Drive Belt Tension To Specifications. See "Drive Belt Tension Adjustment"

STEP 9 Torque Pump Attaching Nuts To Specifications

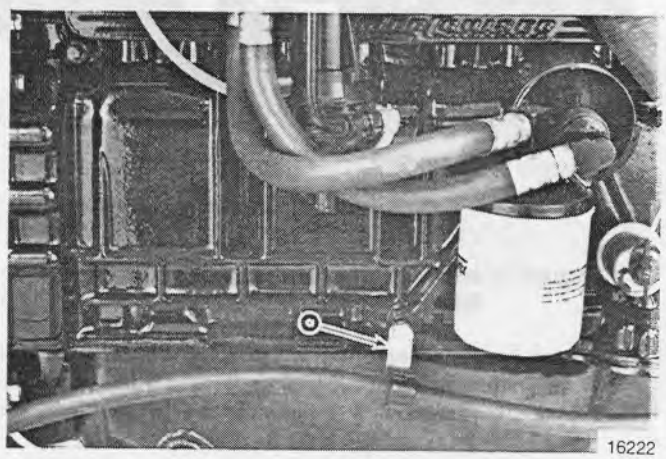
IMPORTANT: Retorque pump attaching nuts after 20 Hrs. of operation.

STEP 10 Reconnect Hydraulic Hoses and Tighten Clamps Securely

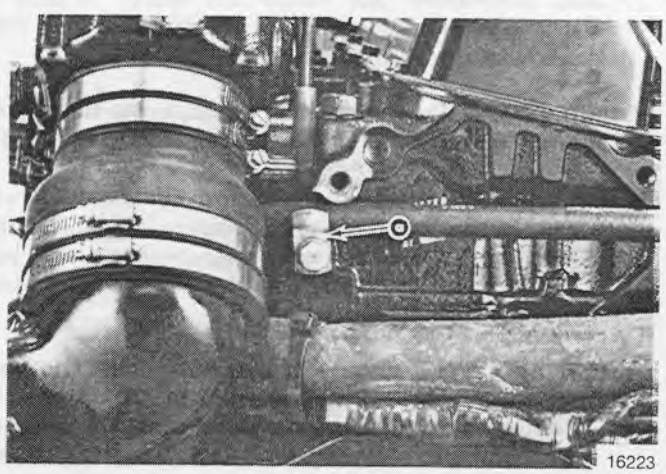


a - Hydraulic Hoses and Clamps

STEP 11 Support Hydraulic Hoses



a - J-Clip

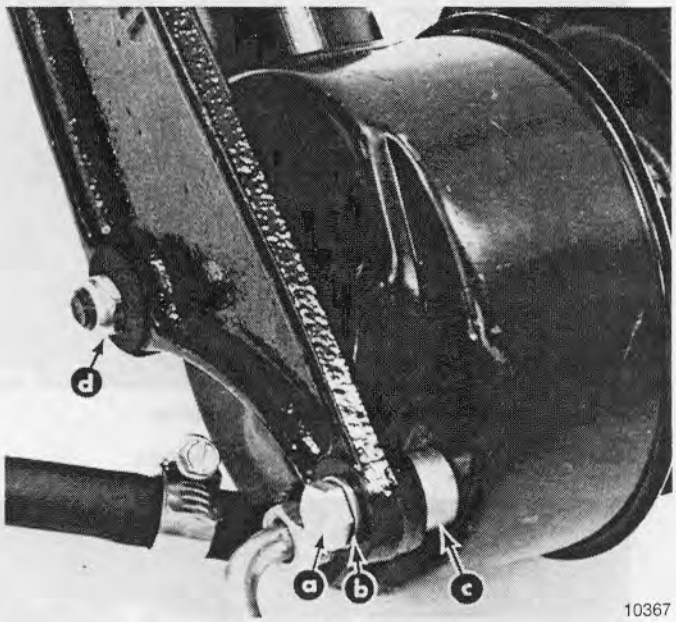


a - J-Clip

STEP 12 Follow Filling and Bleeding Procedures In This Section

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Install mounting bracket on pump with bolt, lockwasher, spacer and nut, as shown in Figure 1. Tighten securely.



10367

a - Bolt - 1-3/4" (44mm) Long
b - Lockwasher
c - Spacer 7/16" (11mm) Thick
d - Locknut - 3/8"-16

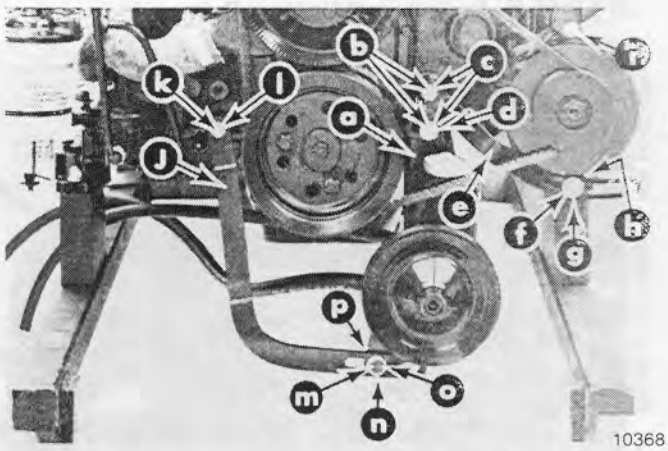
Figure 1. Installing Mounting Bracket on Power Steering Pump

2. Install Power Steering pump and mounting bracket assembly on engine, using bolts, lockwashers and flat washers. (Figure 2) (Reattach alternator brace to top bolt, as shown.) DO NOT tighten bolts at this time.
3. Attach other end of alternator brace to alternator with bolt, lockwasher, flat washer and spacer. (Figure 2) (Install spacer between brace and alternator.) DO NOT tighten bolts at this time.

IMPORTANT: If engine is equipped with Closed Cooling, disregard Step 4 and see "IMPORTANT".

4. Fasten Power Steering pump brace to cylinder block with bolt and lockwasher, as shown in Figure 2. Connect other end of brace to Power Steering pump, as shown, with bolt, lockwasher, flat washer and locknut. DO NOT tighten bolts at this time.

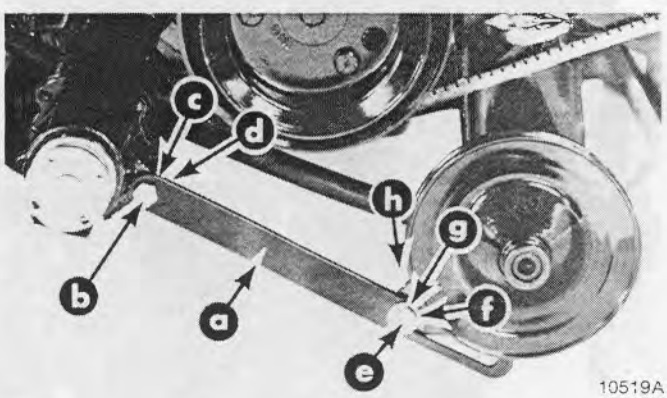
IMPORTANT: If engine is equipped with Closed Cooling, special brace (supplied in "Adaptor Kit 77640A1") must be used, instead of standard brace. Attach brace to seawater pickup pump and Power Steering pump, as shown in Figure 3, using attaching parts. DO NOT tighten bolts at this time.



10368

a - Power Steering Pump and Mounting Bracket Assembly
b - Bolts 1-1/4" (32mm) Long
c - Lockwashers
d - Flat Washer 1/8" (3mm) Thick
e - Brace (Alternator)
f - Bolt 1-1/2" (38mm) Long
g - Flat Washer 3/32" (2mm) Thick
h - Spacer 7/16" (11mm) Thick (Hidden)
i - Alternator to Mounting Bracket Securing Bolt
j - Brace (Power Steering Pump)
k - Bolt 1" (25mm) Long
l - Lockwasher
m - Bolt 1" (25mm) Long
n - Lockwasher
o - Flat Washer 1/16" (1.5mm) Thick
p - Locknut (3/8"-24) (Hidden)

Figure 2. Installing Power Steering Pump

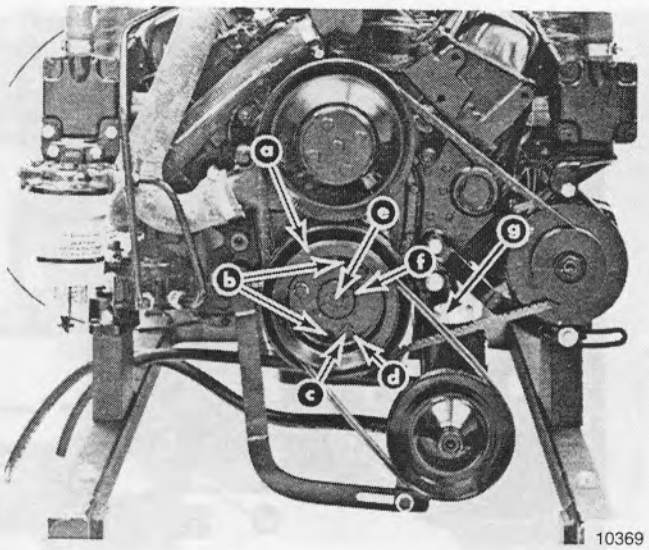


10519A

a - Brace
b - Bolt 1-1/4" (32mm) Long
c - Lockwasher (Hidden)
d - Nut 3/8"-24 (Hidden)
Supplied in Adaptor Kit (77640A1)
e - Bolt 1" (25mm) Long
f - Lockwasher
g - Flat Washer 1/16" (1.5mm) Thick
h - Locknut 3/8"-24 (Hidden)

Figure 3. Installing Special "Adaptor Kit" Brace (Engines Equipped with Closed Cooling Only)

IMPORTANT: Be sure to align holes of drive pulley with locating bosses on crankshaft pulley (Figure 4) when installing in next step.



a - Drive Pulley
b - Pulley Holes and Locating Bosses
c - Bolts 1" (25mm) Long
d - Lockwashers
e - Bolt and Star Washer
f - Flat Washer (3/16" THK)
g - Drive Belt

Figure 4. Installing Power Steering Drive Pulley and Belt

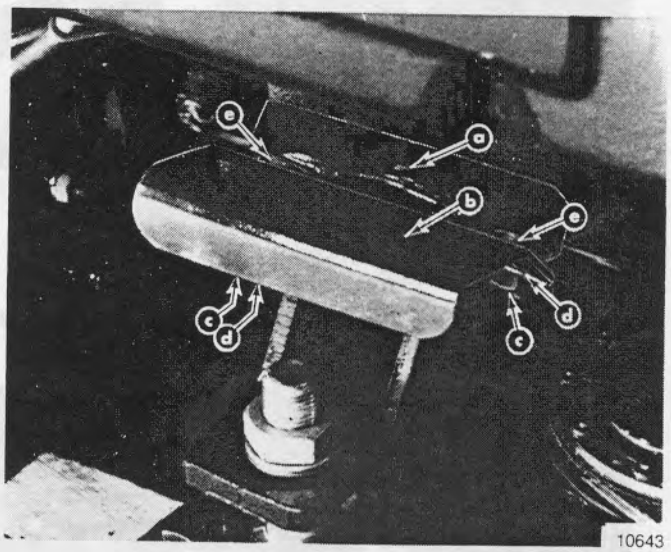
5. Install Power Steering Drive pulley using 1" (25mm) long bolts and hardware. Torque to specifications.
6. Adjust alternator belt to specifications. (Refer to "Drive Belt Adjustment".)
7. Tighten all fasteners securely.

Installing Fluid Cooler

1. Install fluid cooler attaching bracket to engine mount, as shown in Figure 5. Tighten securely.
2. Route fluid cooler and mounting bracket assembly and hoses under engine and up to attaching bracket. (Position hoses to clear moving parts.)
3. Fasten fluid cooler and mounting bracket assembly to attaching bracket, as shown in Figure 6.

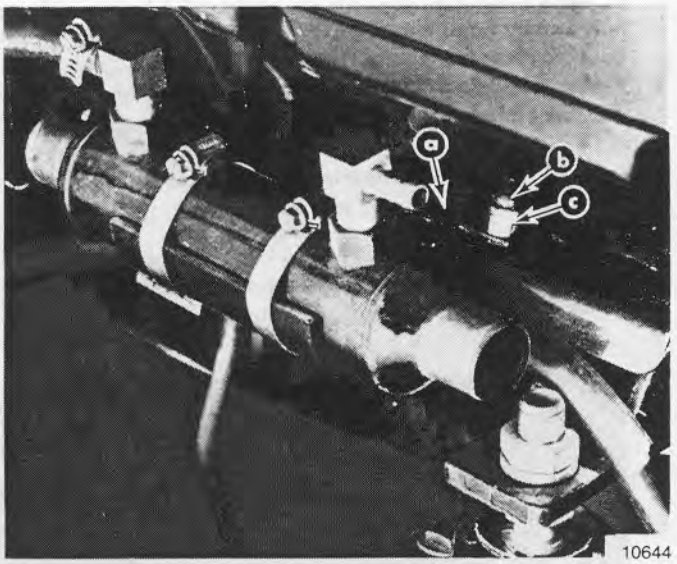
   NOTE: Hydraulic hose was removed from front elbow on oil cooler to allow view of attaching parts.

4. Loosen clamps (securing oil cooler to mounting bracket) and rotate fluid cooler, to position drain plug directly downward, then retighten clamps. (Figure 7)



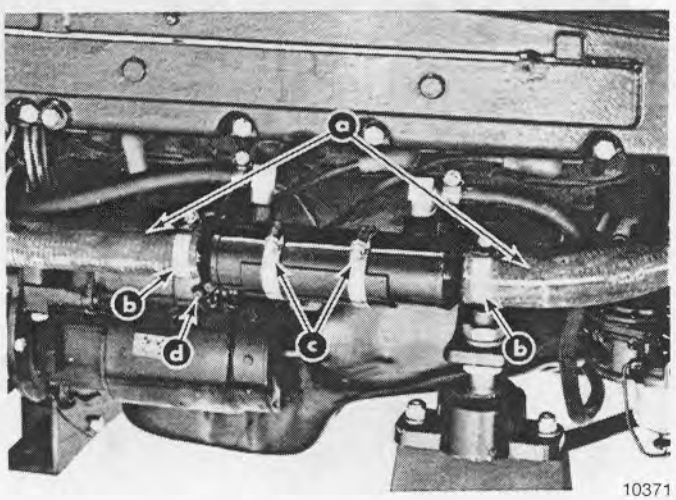
a - Front Starboard (Right) Engine Mount
b - Fluid Cooler Attaching Bracket
c - Bolt 1-5/8" (41mm) Long (2 Req'd)
d - Lockwasher (2 Req'd)
e - Spacer 1/4" (6mm) Thick (2 Req'd)

Figure 5. Installing Fluid Cooler Attaching Bracket



a - Fluid Cooler and Mounting Bracket Assembly
b - Bolt 3/4" (19mm) Long
c - Locknut (3/8"-16)

Figure 6. Installing Cooler and Mounting Bracket Assembly



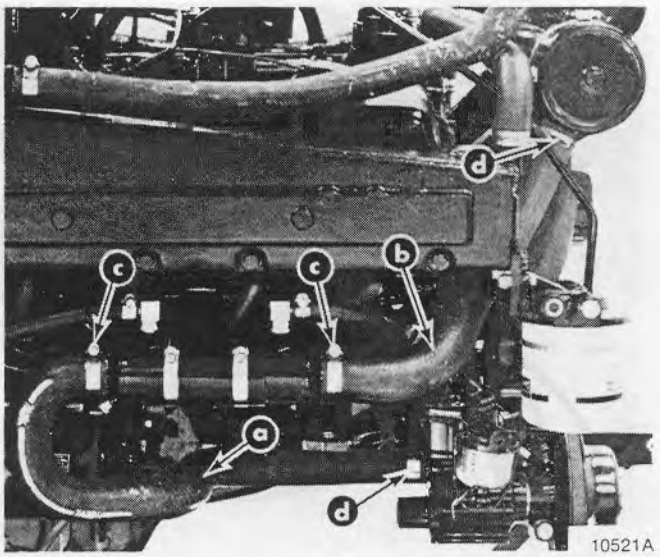
a - Seawater Pickup Hose
b - Hose Clamp
c - Fluid Cooler Mounting Clamps
d - Drain Plug

Figure 7. Connecting Hoses to Fluid Cooler

IMPORTANT: If engine is equipped with Closed Cooling, disregard Step 5 and see "IMPORTANT", following.

5. Connect water hoses to fluid cooler. (Figure 7) Secure hoses with hose clamps.

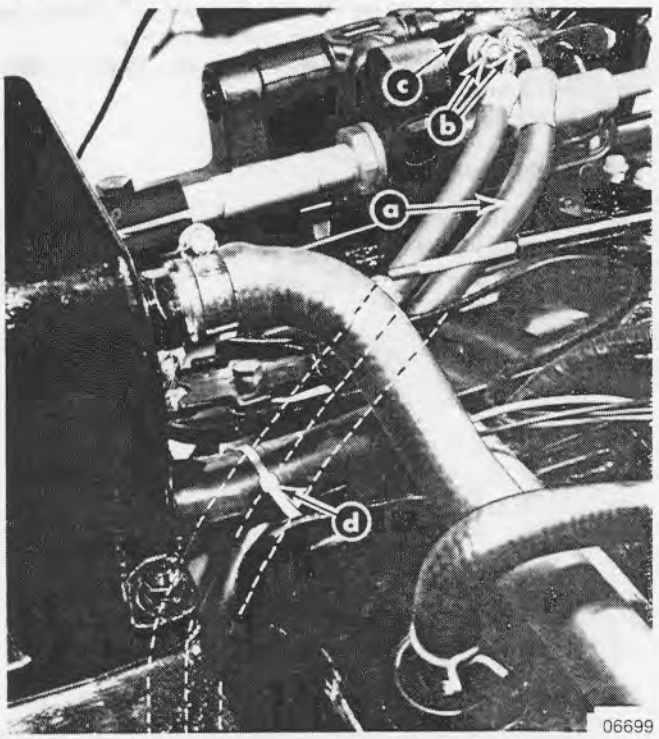
IMPORTANT: If engine is equipped with Closed Cooling, special hoses from "Adaptor Kit (77640A1)" must be used to connect fluid cooler to seawater pickup pump and heat exchanger. Install hoses, as shown in Figure 8, using clamps.



a - Seawater Pickup Pump to Fluid Cooler Hose
b - Fluid Cooler to Heat Exchanger Hose
c - Hose Clamp
d - Hose Clamp

Figure 8. Installing Special "77640A1 Adaptor Kit" Hoses (Closed Cooling Equipped Engines Only)

Connecting Hydraulic Hoses



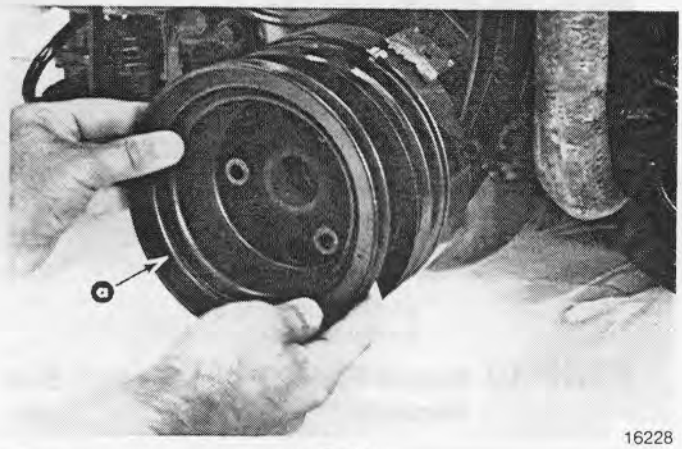
a - Hydraulic Hoses
b - Hydraulic Hose Fittings
c - Control Valve Assembly
d - Sta-Strap(s)

Figure 9. Connecting Hydraulic Hoses

1. Route hoses up to Power Steering control valve. (Figure 9)
2. Position hoses to clear moving parts, then fasten in place with sta-strap(s), as shown in Figure 9.
3. Follow "Filling and Bleeding System" procedures in this section.

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

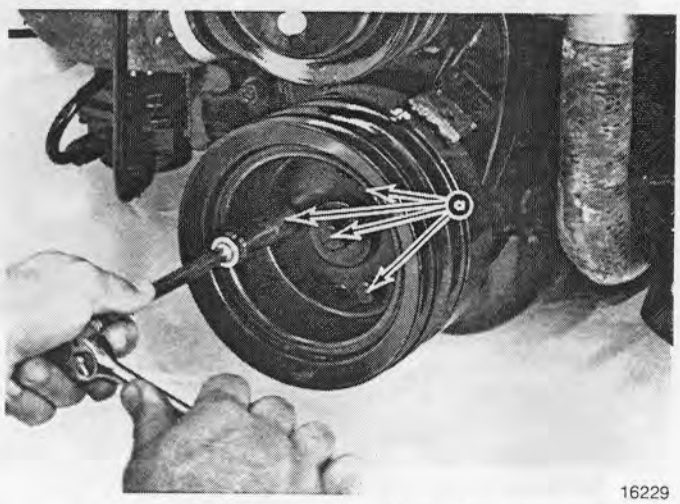
STEP 1 Install Single Groove Pulley



16228

a - Pulley

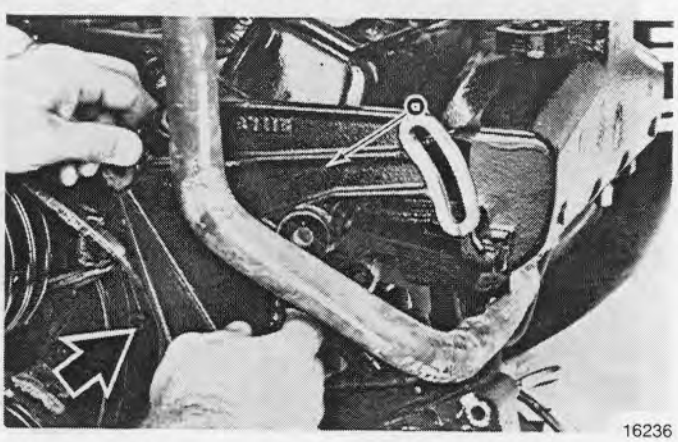
STEP 2 Torque Screws to Specifications



16229

a - Screws - 3 are 1" (25mm) Long

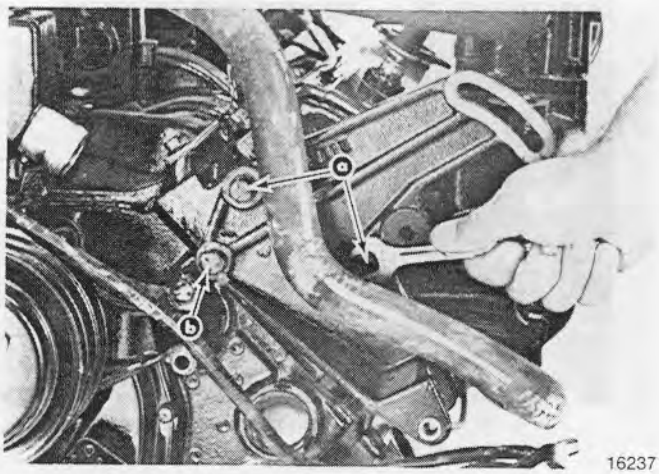
STEP 2 Install Power Steering Pump/ Alternator Mounting Bracket



16236

a - Bracket

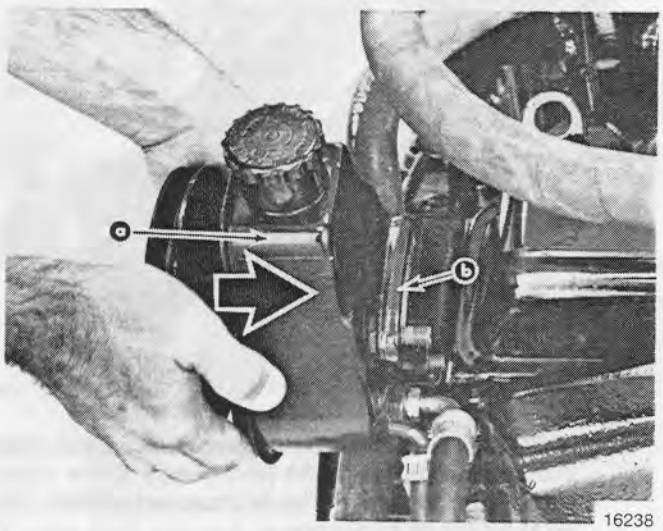
STEP 3 Tighten Attaching Screws Securely



16237

a - Install 2 1-1/4" (32mm) Long Bolts and Lockwashers
b - Do Not Install at This Time

STEP 4 Position Power Steering Pump

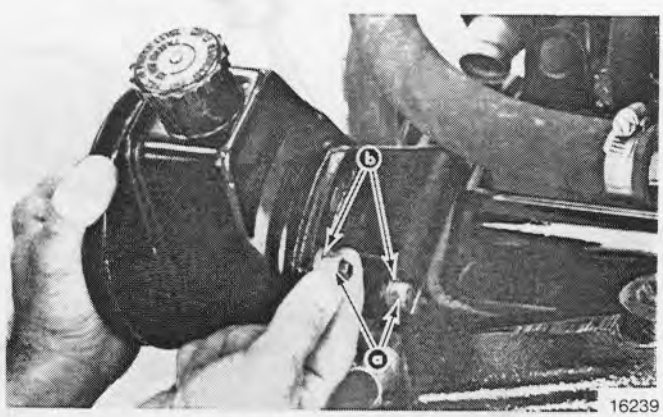


16238

a - Pump
b - Bracket

STEP 5 Secure Pump. Tighten Nuts Securely

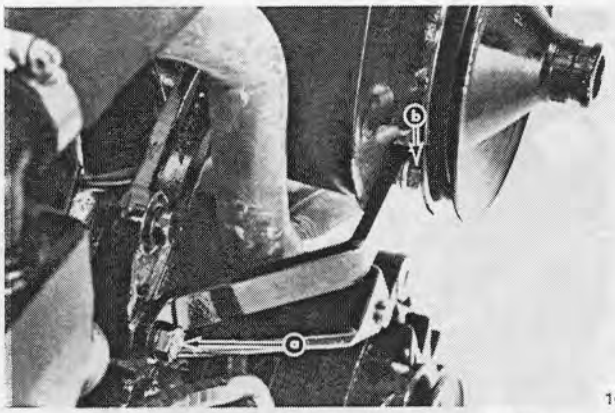
IMPORTANT: Pump is secured with two metric nuts (usually blue in color) and washers.



16239

a - 15mm Nuts
b - Washers

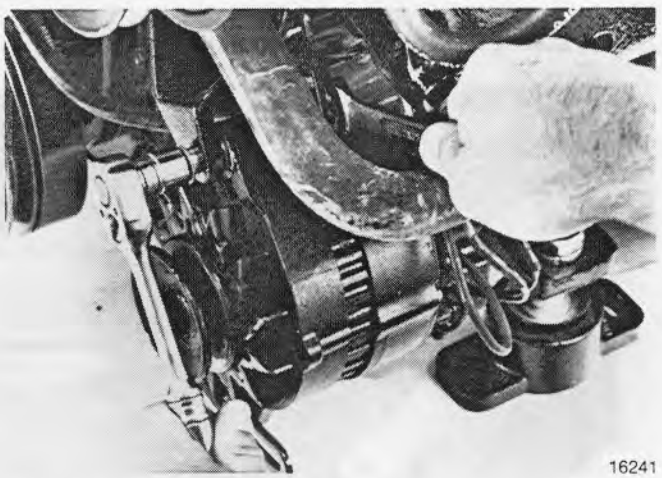
STEP 6 Attach Power Steering Pump Brace



16240

a - 1-1/2" (38mm) Long Bolt and Lockwasher
b - Metric Bolt (Blue) and Lockwasher

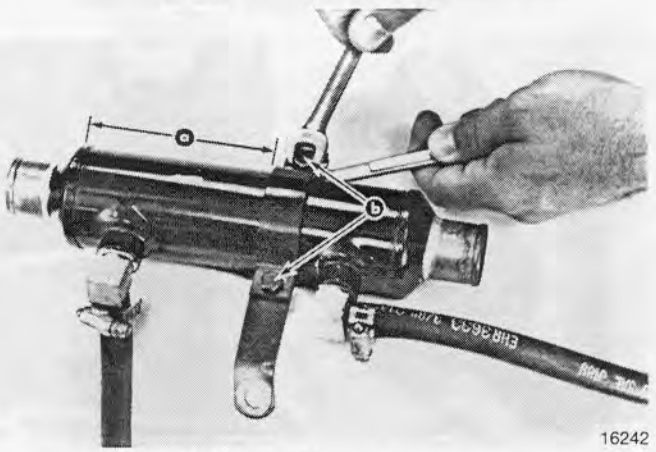
STEP 7 Attach Alternator to Bracket



16241

IMPORTANT: Pictures shown are for 898R/228R/260R engines. The 330 (B-W) may differ slightly from pictures shown. The fluid cooler for 898R/228R/260R engines cools power steering fluid only. The fluid cooler for the 330 (B-W) cools engine oil and power steering fluid.

STEP 8 Install Fluid Cooler Mounting Bracket

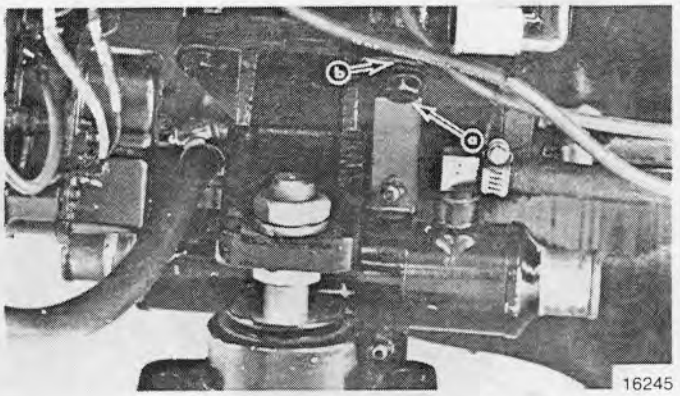


16242

a - 4-1/8" (104mm)
b - 2-3/4" (19mm) Long Bolts and Nuts

STEP 9 Position Fluid Cooler

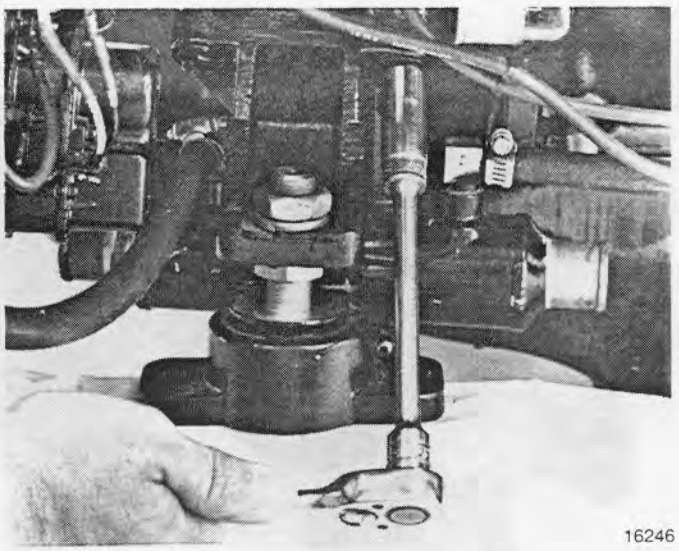
IMPORTANT: Flat washer MUST BE place BETWEEN engine block and mounting bracket.



16245

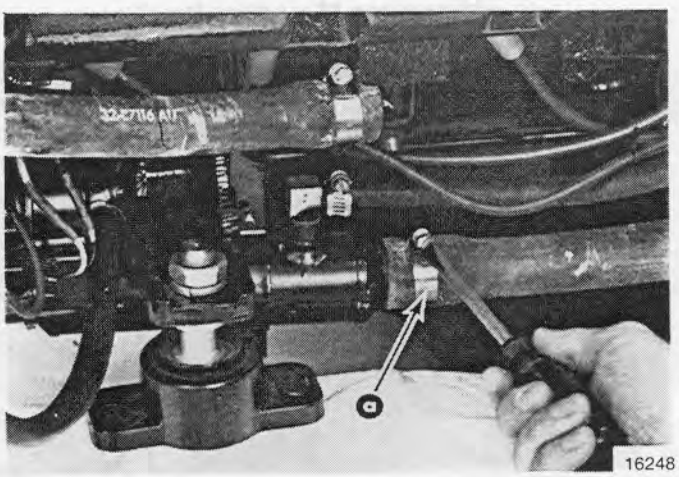
a - 1-3/8" (35mm) Bolt
b - Flat Washer

STEP 10 Secure Fluid Cooler. Tighten Bolt Securely



16246

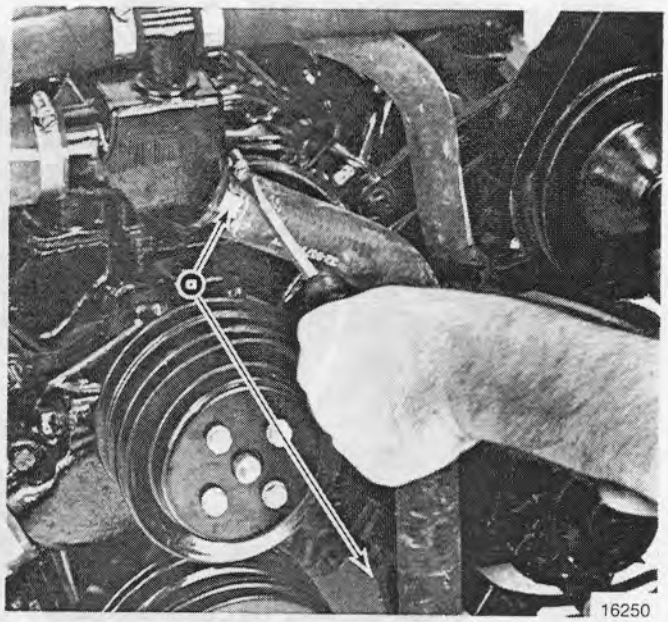
STEP 11 Install Water Hose and Tighten Clamp Securely



16248

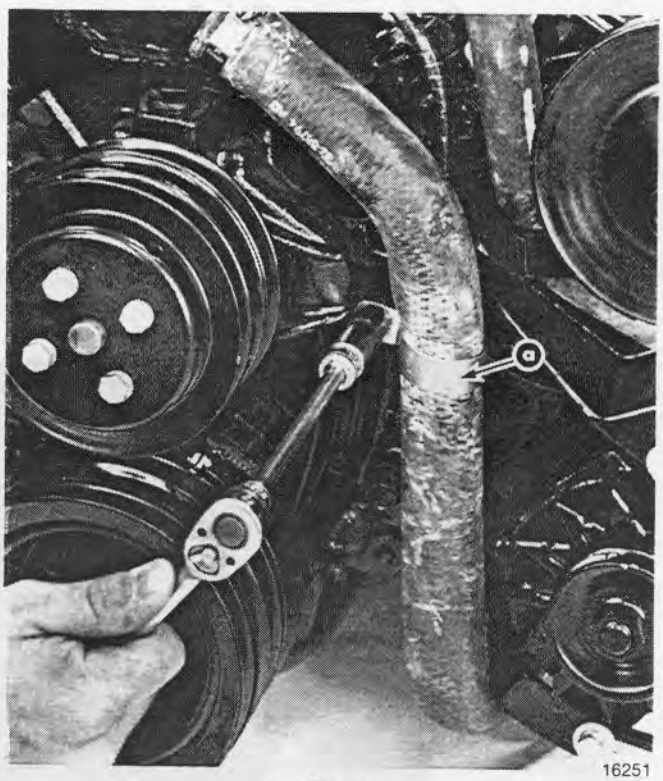
a - Hose Clamp and Hose

STEP 12 Install Water Hose and Tighten Hose Clamps Securely



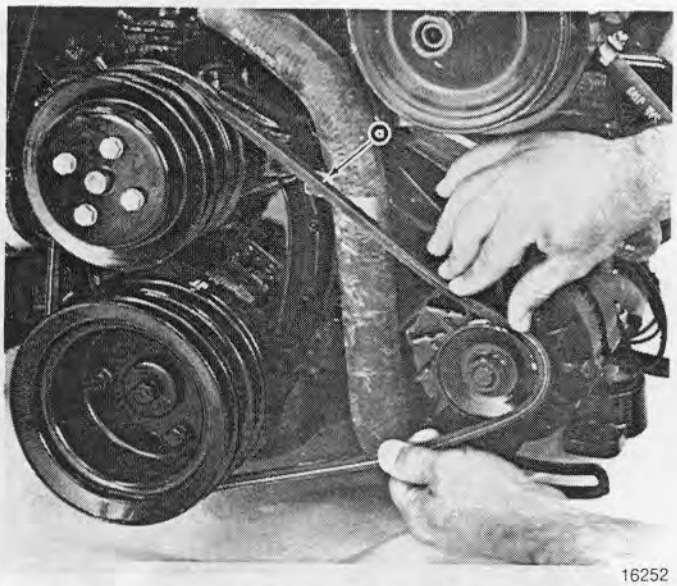
a -Hose Clamps (Lower Clamp Hidden)

STEP 13 Secure Hose to Circulating Pump



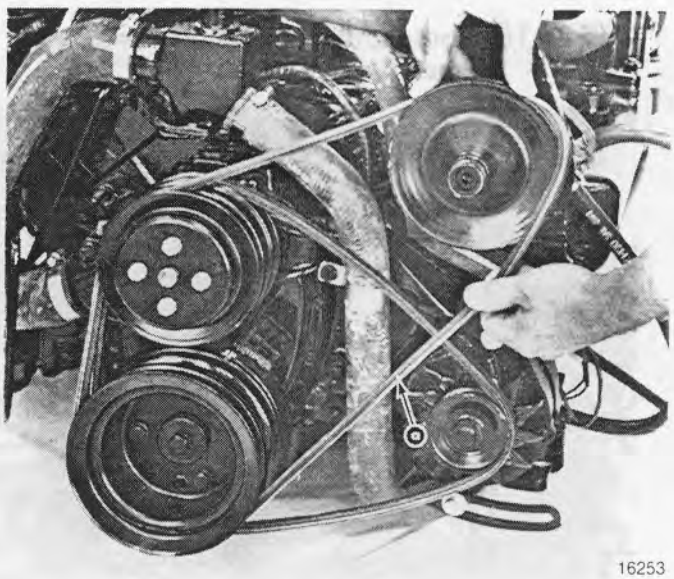
a - Clamp

STEP 14 Install Alternator Drive Belt



a - Alternator Drive Belt

STEP 15 Install Power Steering Drive Belt

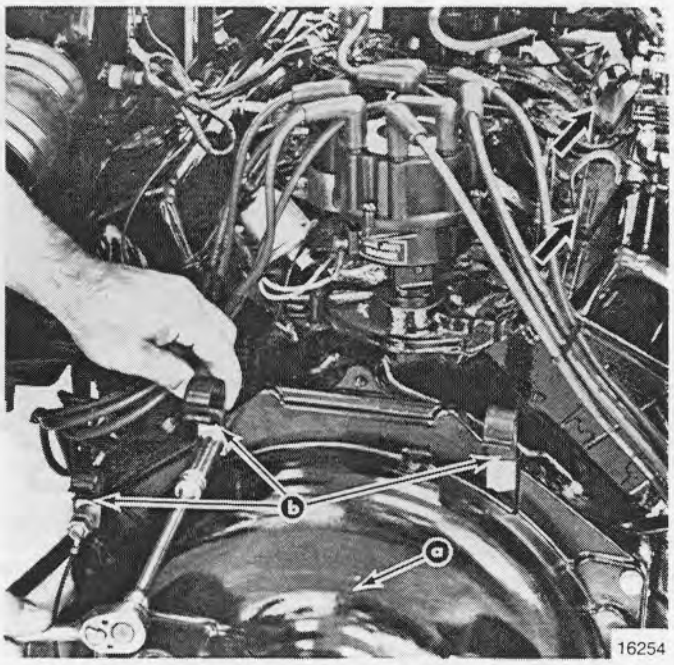


a - Power Steering Drive Belt

STEP 16 Adjust Drive Belt Tension To Specifications. See "Drive Belt Tension Adjustment".

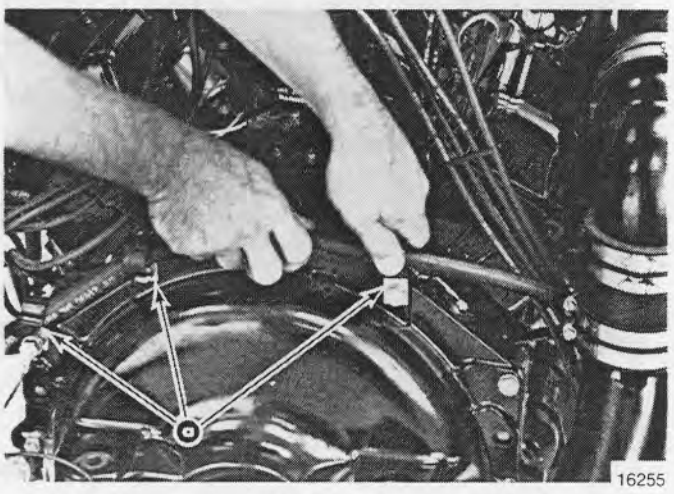
IMPORTANT: DO NOT pry against side of pump, as damage may result.

STEP 17 Install J-Clamps



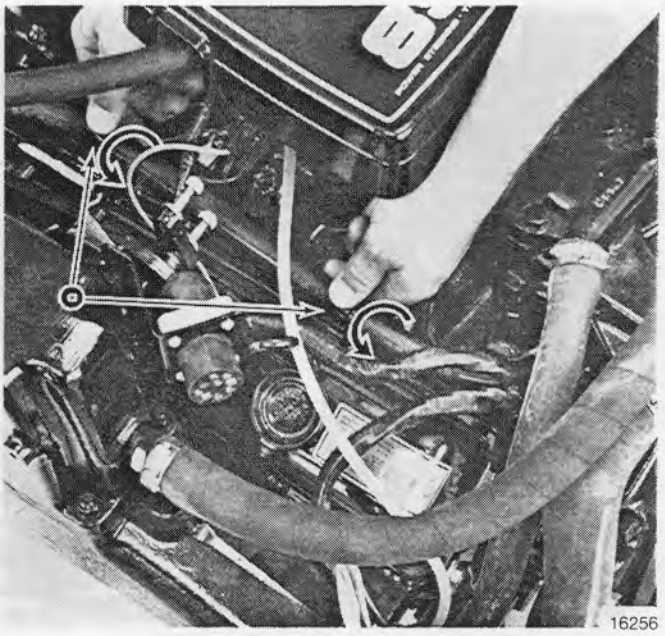
a - Flywheel Housing
b - J-Clamps

STEP 18 Route and Secure Low Pressure Hose



a - J-Clamps

STEP 19 Route and Secure High Pressure Hose



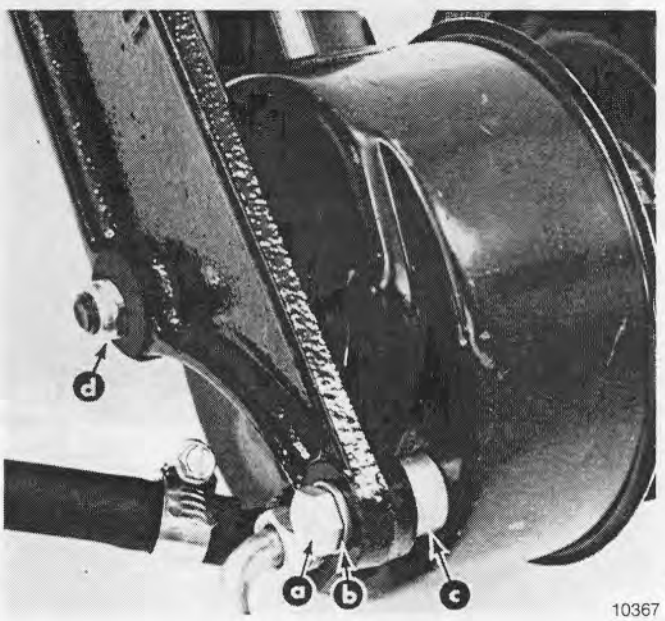
a - J-Clamps

STEP 20 Follow Filling and Bleeding Procedures in This Section

MCM 330

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding

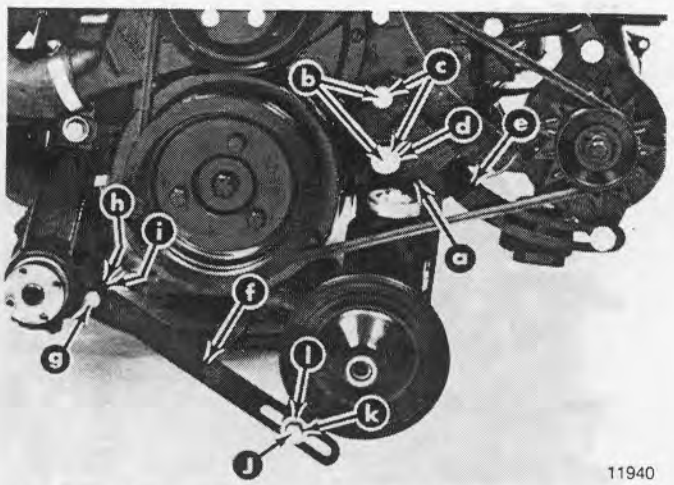
1. Install mounting bracket on pump with spacer and locknut, as shown in Figure 1. Tighten securely.



a - Screw 1-3/4" (44mm) Long
b - Lockwasher
c - Spacer [7/16" (1mm) THK]
d - Locknut (3/8"-16)

Figure 1. Mounting Bracket Installed on Pump

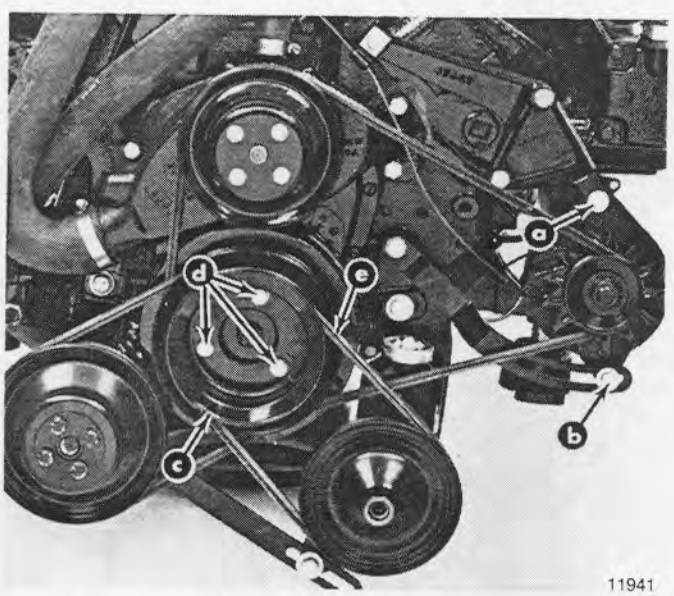
2. Check fitting and clamp, which secure hydraulic hoses to pump, for adequate tightness.
3. Attach Power Steering pump and mounting bracket assembly and alternator brace to cylinder block with screws, lockwashers and flat washer. (Figure 2) DO NOT tighten screws at this time.



11940

a - Power Steering Pump and Mounting Bracket Assembly
b - Screws 1-1/2" (38mm) Long
c - Lockwashers
d - Flat Washer
e - Alternator Brace
f - Power Steering Pump Brace
g - Screw
h - Lockwasher (Hidden)
i - Nut (Hidden)
j - Screw 1" (25mm) Long
k - Lockwasher
l - Flat Washer

Figure 2. Installing Power Steering Pump



11941

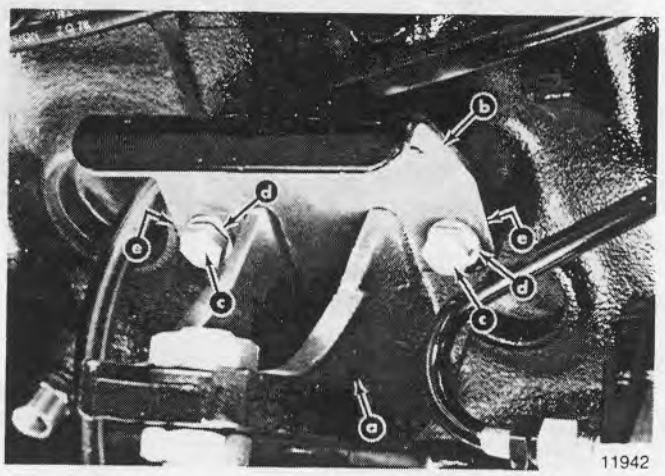
a - Alternator Mounting Bolt
b - Alternator Brace to Alternator Attaching Screw
c - Power Steering Pump Drive Pulley
d - Screws and Lockwashers
e - Power Steering Pump Drive Belt

Figure 3. Power Steering Pump Drive Belt Installed

4. Attach Power Steering pump brace to seawater pickup pump with thinner lockwasher and screw and nut. (Figure 2) DO NOT tighten screw at this time.
5. Attach other end of brace to Power Steering pump with screw, lockwasher and flat washer. (Figure 2) DO NOT tighten screw at this time.
6. Install Power Steering pump pulley to crankshaft pulley and harmonic balancer with screws and lockwashers. (Figure 3) Torque screws to specifications.
7. Adjust alternator and power steering drive belts to specifications (Refer to "Drive Belt Tension Adjustments" in this section).
8. Tighten all fasteners securely.

Installing Fluid Cooler

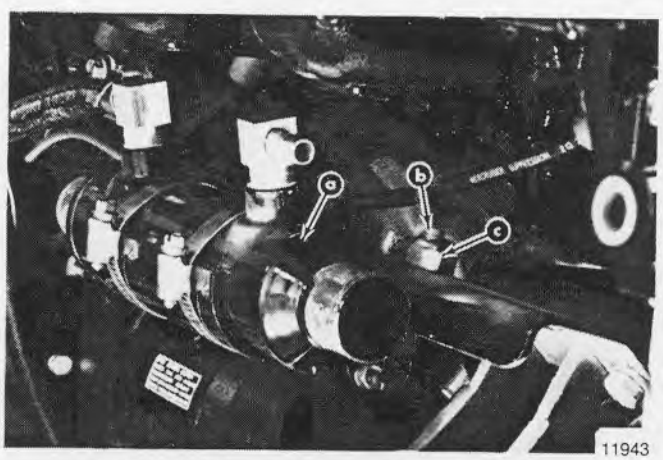
1. Install fluid cooler attaching bracket to engine mount with lockwashers and spacers, as shown in Figure 4. (Install spacers between bracket and mount.) Tighten securely.



11942

a - Front Starboard Engine Mount
b - Fluid Cooler Attaching Bracket
c - Screw 1-5/8" (41mm) Long
d - Lockwasher
e - Spacer 3/32" (2mm) THK (Hidden)

Figure 4. Power Steering Fluid Cooler Attaching Bracket Installed

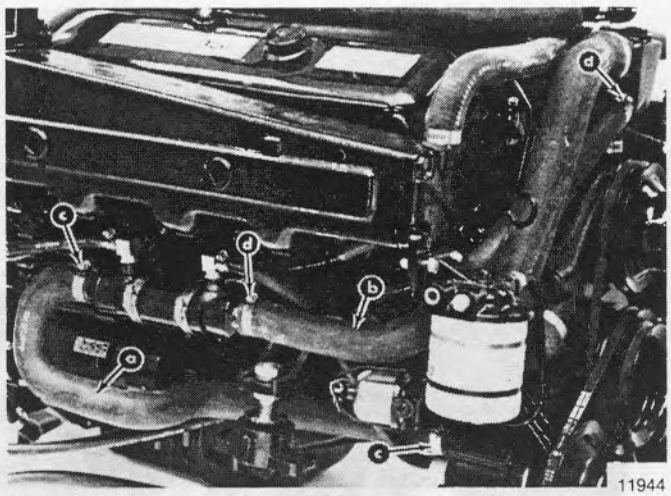


11943

a - Fluid Cooler and Mounting Bracket Assembly
b - Screw 3/8" x 1" (25mm) Long
c - Locknut (3/8"-16)

Figure 5. Power Steering Fluid Cooler Secured

2. Route hydraulic hose and fluid cooler and mounting bracket assembly under engine and up to attaching bracket. Position hose to clear moving parts.
3. Fasten fluid cooler and monting bracket assembly to attaching bracket with screw and locknut, as shown in Figure 5. Tighten securely.
4. Install seawater pickup pump to Power Steering fluid cooler hose and Power Steering fluid cooler to thermostat housing hose as shown in Figure 6. Secure hose with clamps.



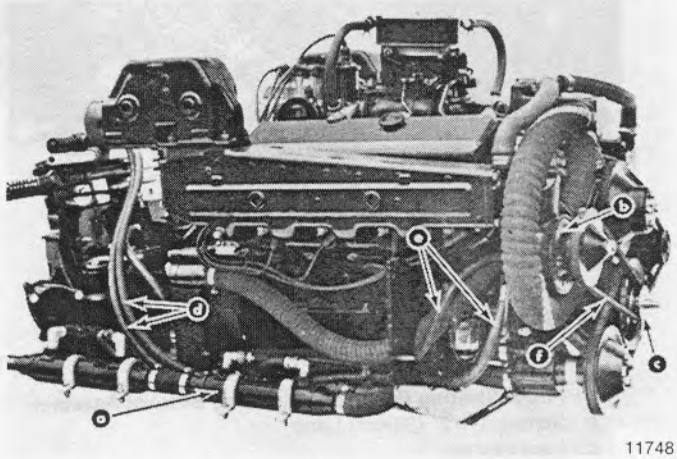
a - Seawater Pickup Pump to Fluid Cooler Hose
b - Fluid Cooler to Thermostat Housing Hose
c - Hose Clamps
d - Hose Clamps

Figure 6. Power Steering Fluid Cooler Hoses Installed

5. Check hose clamps, which secure fluid cooler to mounting bracket, to ensure that they are tight. Also, check tightness of hose clamps that secure hydraulic hoses to elbow fittings on fluid cooler.

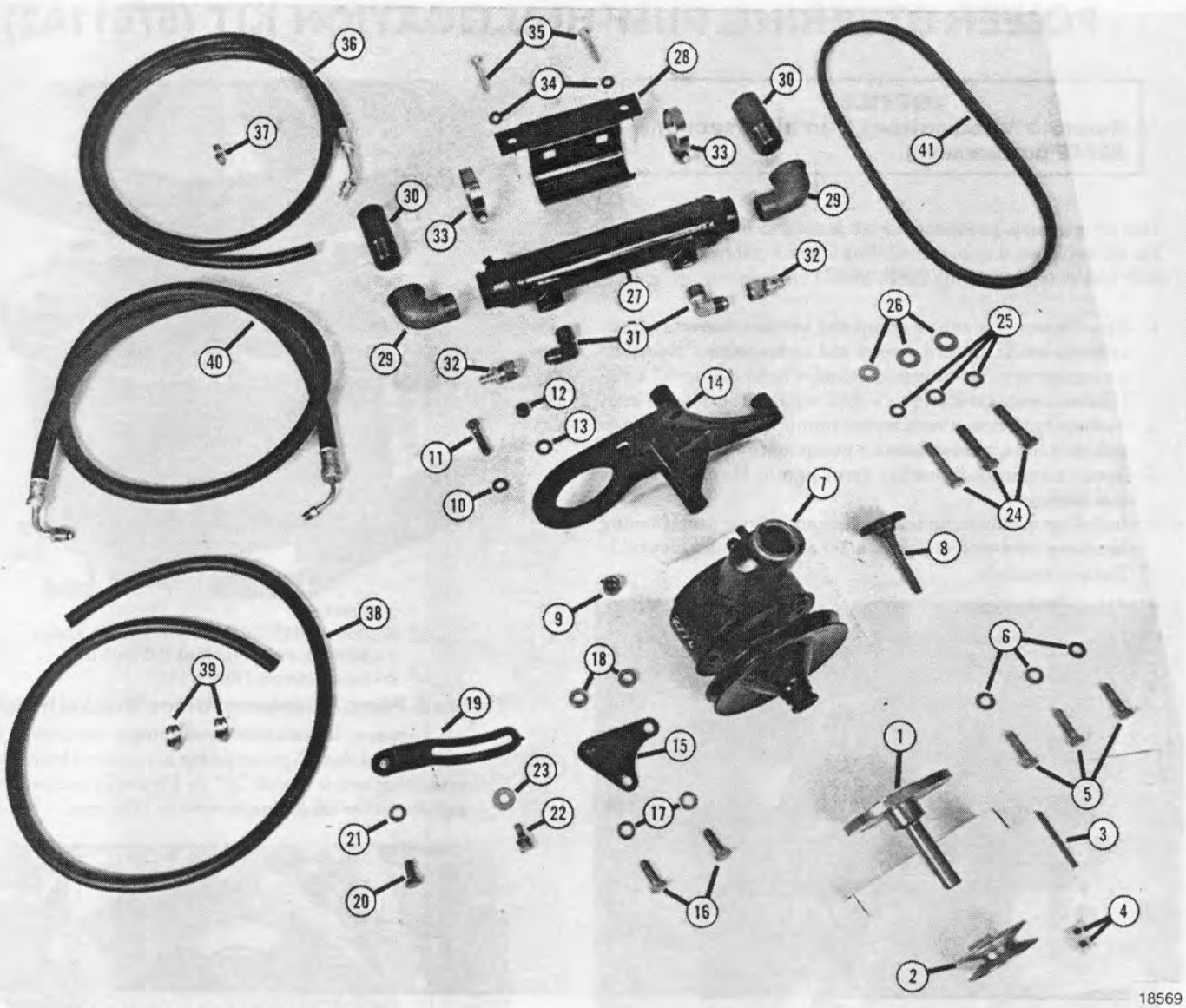
MCM 370/400 and MCM 400/440/460 Cyclone/ 475 Turbo

Power Steering Component Location



a - Power Steering Fluid Cooler (Mounts on Boat Stringer)
b - Power Steering Pump (Starboard Mounted)
c - Power Steering Drive Pulley
d - Hydraulic Hoses — Shows Proper Routing
e - Hydraulic Hoses — Shows Proper Routing
f - Power Steering Drive Belt

Figure 1. Power Steering Component Location



DRIVE PULLEY ASSEMBLY

1 - Adaptor
2 - Pulley
3 - Key
4 - Set Screws (Pulley to Adapator) (2)
5 - Bolts (Adaptor to Harmonic Balancer) (3)
6 - Lockwashers (3)

POWER STEERING PUMP and MOUNTING BRACKET ASSEMBLY

7 - Pump
8 - Cap and Dipstick
9 - Spacer 7/16" (11mm) Thick - Between Pump and Mounting Bracket
10 - Lockwasher (1)
11 - Bolt (Pump to Mounting Bracket)
12 - Nut (Pump to Mounting Bracket)
13 - Flatwasher (1)
14 - Mounting Bracket
15 - Adjustment Bracket
16 - Bolts (Bracket to Pump) (2)
17 - Lockwashers (2)
18 - Spacers 1/4" (6mm) Thick - Between Bracket and Pump (2)
19 - Adjustment Brace
20 - Bolt (Brace to Bracket)
21 - Lockwasher (1)
22 - Bolt (Brace to Mounting Bracket) (1)
23 - Flatwasher (1)
24 - Bolt (Mounting Bracket to Engine) (3)
25 - Lockwashers (3)
26 - Flatwasher (3)

COOLER ASSEMBLY

27 - Cooler
28 - Mounting Bracket
29 - Elbow (2) (Seawater Hose)
30 - Bayonet (2) (Seawater Hose)
31 - Elbow (2) (Hydraulic Return Hose)
32 - Bayonet Fitting (2) (Hydraulic Return Hose)
33 - Clamps (Cooler to Bracket)
34 - Lockwashers (2)
35 - Lag Screws (2) (Bracket to Stringer)

MISCELLANEOUS

36 - Return Hose (Transom Plate to Cooler)
37 - Clamp (1)
38 - Return Hose (Cooler to Pump)
39 - Clamps (2)
40 - Pressure Hose (Pump to Transmom Plate)
41 - Drive Belt

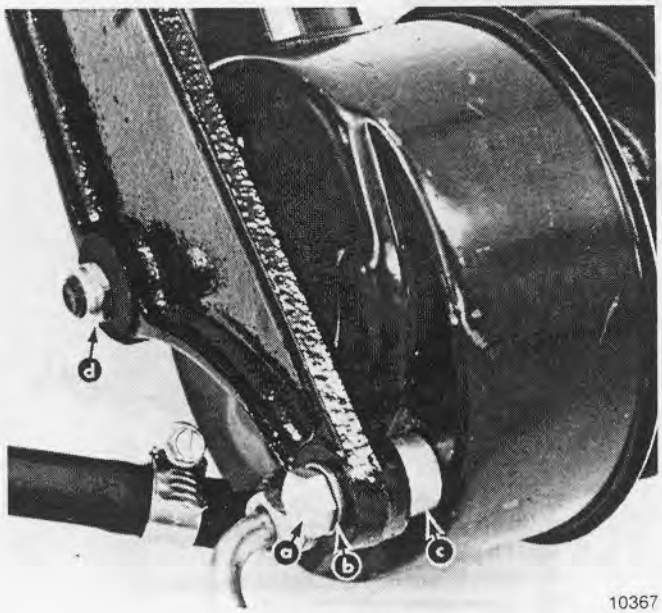
Figure 2. Exploded View of MCM 370/Hi-Performance Engine Power Steering Components

POWER STEERING PUMP RELOCATION KIT (57611A2)

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

This kit relocates pump from high mount to low mount. This kit must be used when installing closed cooling on MCM 898/228/260 (not 898R/228R/260R) engines.

1. Remove power steering pump and bracket assembly from cylinder head. Discard screws and lock washers. Reinstall wiring harness "J" clamp to cylinder head, using ⅜" x ½" (18mm) long screw and new lock washer (both from kit).
2. Remove both hoses from rear of pump. Quickly plug hoses and both hose connections on pump, to prevent fluid loss.
3. Remove mounting bracket from pump. Discard bracket and fasteners.
4. Install new mounting bracket (from kit) on pump (using fasteners and spacer from kit), as shown in Figure 1. Tighten securely.

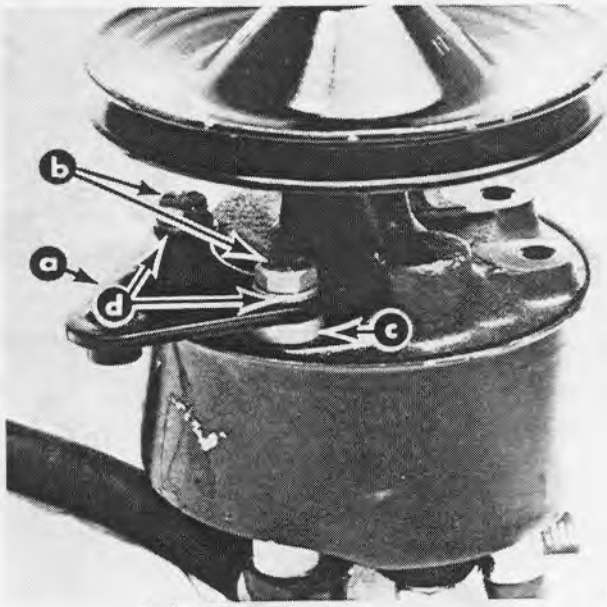


10367

a - Screw 3/8" x 1-3/4" (44mm) Long
b - Lockwasher
c - Spacer [7/16" (11mm) THK]
d - Locknut 3/8"-16

Figure 1. Pump Mounting Bracket Installation

5. Install adjustment brace bracket (from kit) on pump (using hex head screws, spacers and lockwashers from kit), as shown in Figure 2. Tighten securely.
6. Remove alternator adjustment brace. Retain brace and washers. Discard screws.
7. Remove power steering low pressure hose from front of power steering fluid cooler and install new hose (from kit), using new hose clamp (from kit). Tighten clamp securely.
8. Reinstall power steering high pressure hose and low pressure hose to pump (use new hose clamp, from kit, to secure low pressure hose). Tighten fitting and hose clamp securely.
9. Install power steering pump/bracket assembly, alternator adjustment brace (retained in Step 6) and power steering pump adjustment brace (from kit) on engine, as shown in Figure 3. Be sure to install flat washer (item "d" in Figure

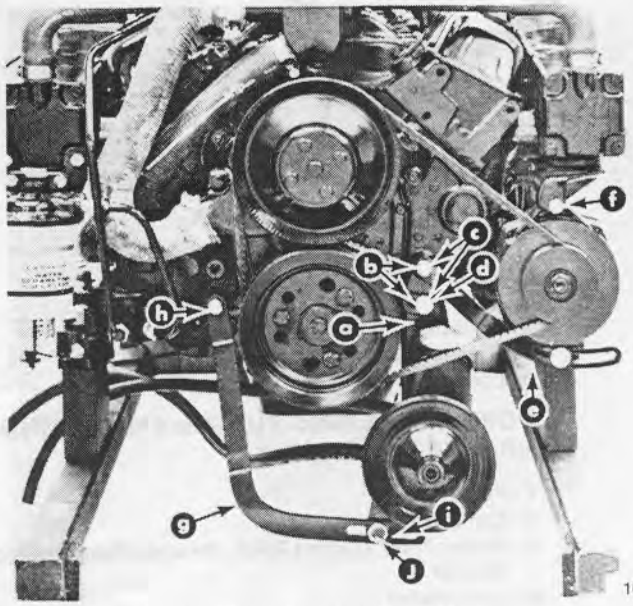


14590

a - Bracket
b - Screws, METRIC (10mm x 25mm Long)
c - Spacers (One Hidden) (10mm I.D.)
d - Lockwashers (10mm I.D.)

Figure 2. Pump Adjustment Brace/Bracket Installation

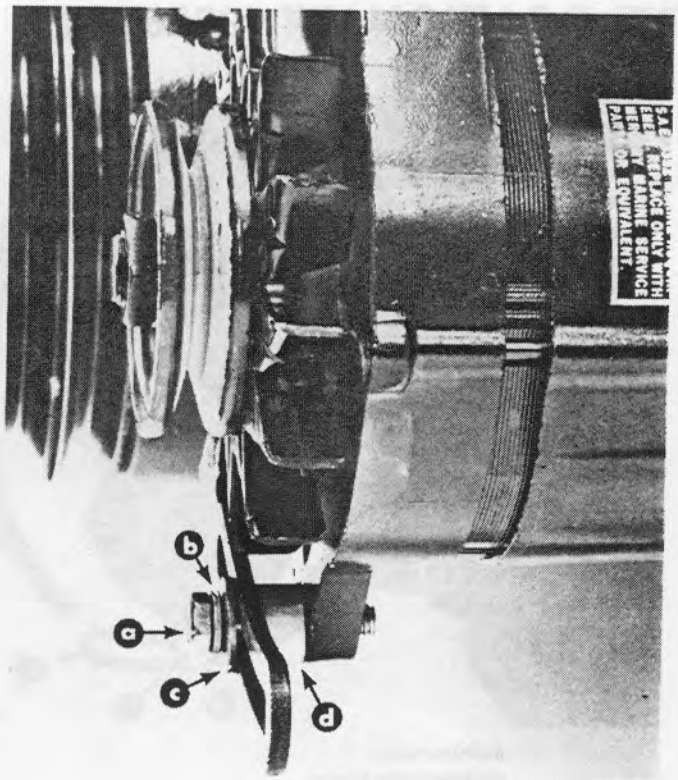
3) between lockwasher and pump mounting bracket adjustment slot. Tighten pump adjustment brace to engine attaching screw (item "h" in Figure 3) securely. Do not tighten other attaching screws at this time.



10368

a - Power Steering Pump/Bracket Assembly
b - Screws [3/8" x 1-1/2" (38mm) from Kit]
c - Lockwasher (from Kit)
d - Flat Washer (from Kit)
e - Alternator Adjustment Brace
f - Screw, Alternator Mounting
g - Power Steering Pump Adjustment Brace (from Kit)
h - Screw [3/8"-16x7/8" (22mm)], Lockwasher and Flat Washer (All from kit)
i - Flat Washer (from Kit)
j - Screw [3/8" x1" (22mm) from Kit]

Figure 3. Power Steering Pump Installation

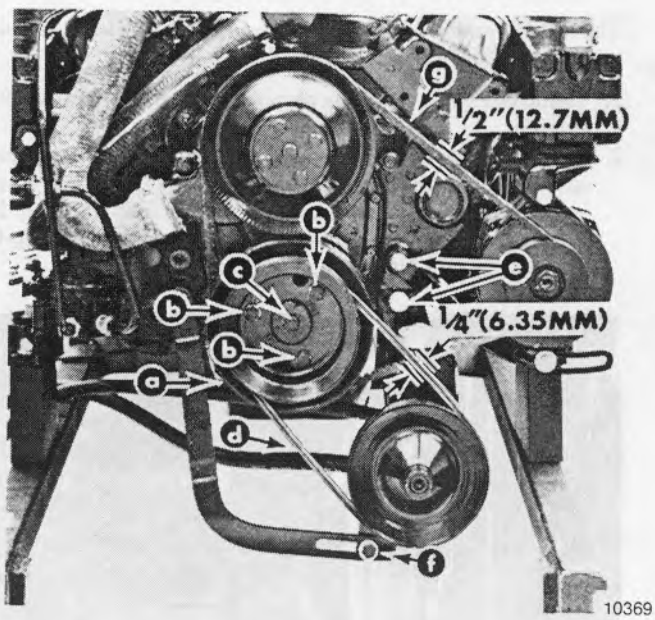


13689

a - Screw [3/8" x 1-1/2" (38mm); from Kit]
b - Lockwasher
c - Flat Washer
d - Spacer [7/16" (11mm) THK; from Kit]

Figure 4. Alternator Adjustment Brace Installation

10. Remove screws which secure outer pulley to harmonic balancer and discard outer pulley only. Install new single groove pulley (from kit) using original fasteners. Torque fasteners to specifications.
11. Secure alternator adjustment brace to alternator with hex head screw and spacer (from kit) and washers (retained in Step 6), as shown if Figure 4. Make sure lockwasher is installed between screw head and flat washer. Do not tighten at this time.
12. Install new power steering pump drive belt (from kit). Adjust belt tension to specifications. Refer to "Drive Belt Adjustments" in this section.
13. Tighten all fasteners securely.
13. Adjust Alternator drive belt tension to specifications. (Refer to "Drive Belt Adjustments" in this section).
14. Tighten all fasteners securely.



10369

a - Power Steering Pump Drive Pulley (Single Groove)
b - Screws, Drive Pulley to Harmonic Balancer
c - Screw, Pulleys/Balancer to Crankshaft
d - Power Steering Pump Drive Belt
e - Screws, Pump Mounting Bracket
f - Screw, Pump Adjustment Brace
g - Alternator Drive Belt

Figure 5. Pump Mounting Kit Installed

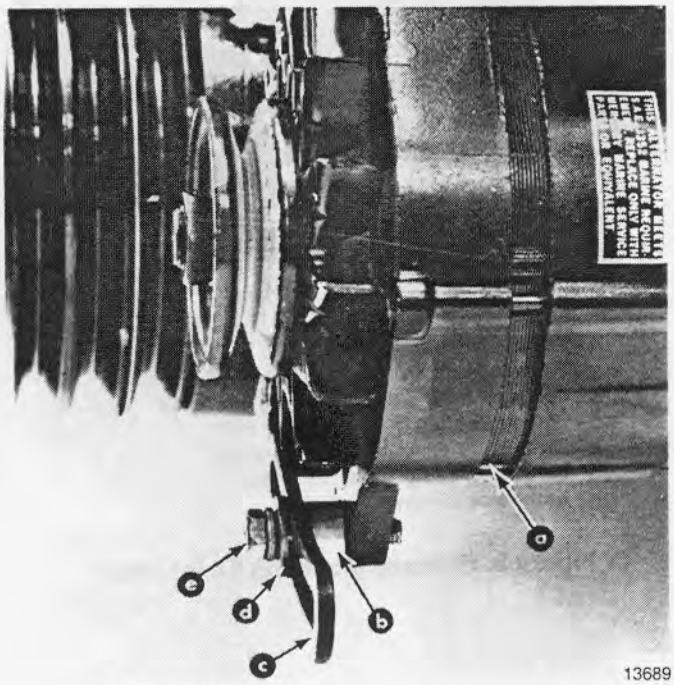
POWER STEERING PUMP RELOCATION KIT (90981A1)

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

FOR STERN DRIVE MCM 898/228/260 WITHOUT CLOSED COOLING

This kit relocates pump from a low mount to a high mount as used on MCM 898R/228R/260R.

1. Remove Power Steering pump and mounting bracket from engine.
2. Remove alternator brace from alternator (discard spacer and bolt; retain brace and flat washer). (Figure 1) Reconnect brace to alternator, use 5/16" x 7/8" (22mm) long bolt (from kit) along with flat washer retained earlier. (Figure 2) DO NOT tighten bolt at this time.

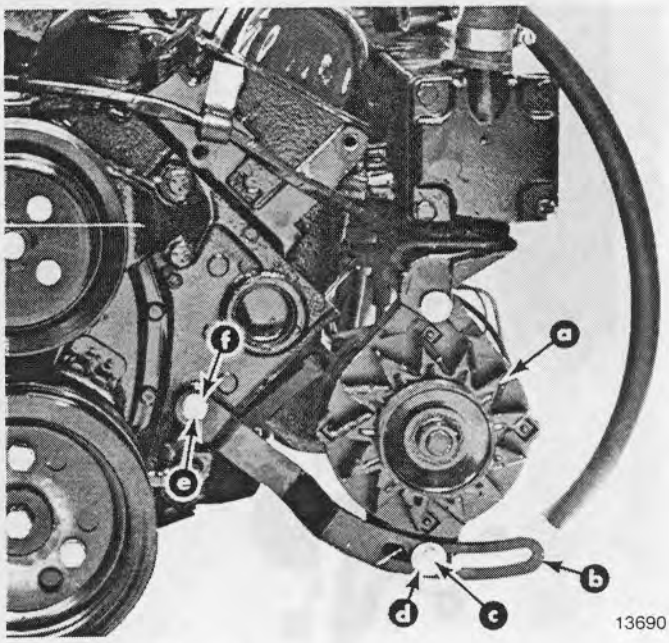


13689

a - Alternator
b - Spacer (Remove and Discard)
c - Alternator Brace (Retain)
d - Flat Washer (Retain)
e - Bolt and Lockwasher (Remove and Discard)

Figure 1. Removing Alternator Brace

3. Reconnect alternator brace to top hole in engine block, using ⅜" x ¾" (19mm) bolt (from kit) and original lockwasher that was removed in Step 1. (Figure 2) DO NOT tighten bolt at this time.



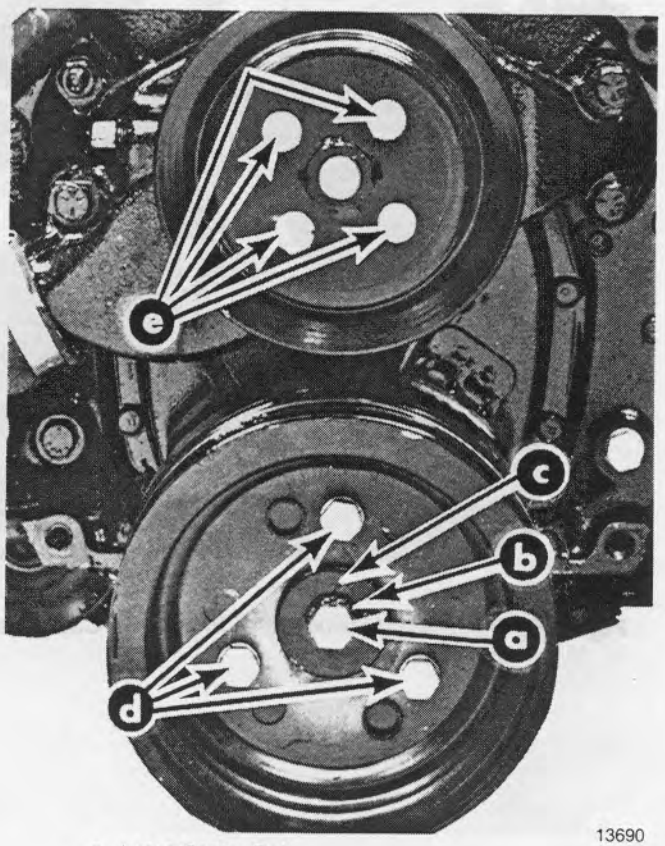
13690

a - Alternator
b - Alternator Brace
c - Bolt [5/16" x 7/8" (22mm) Long; from Kit]
d - Flat Washer (Original)
e - Bolt [3/8" x 3/4" (19mm) Long; from Kit]
f - Lockwasher (Original)

Figure 2. Reconnecting Alternator Brace

4. Remove (and retain) 3 bolts and lockwashers which secure crankshaft pulleys to harmonic balancer. Also remove (and retain) large bolt, star washer and flat washer from center of pulley. Remove 2-groove crankshaft pulley.
5. Install new single-groove crankshaft pulley (supplied with kit) with bolts and washers that were retained in Step 4. (Figure 3) Torque all bolts to specifications.
6. Remove (and retain) 4 bolts and lockwashers which secure circulating pump pulley to circulating pump. Remove and discard pulley.
7. Install new 3-groove circulating pump pulley (from kit) with bolts and lockwashers (retained in Step 6). (Figure 3) Torque bolts to specifications.
8. Install mounting bracket (supplied with kit) on pump with ⅜"-16 x 1½" (38mm) bolt, lockwasher, flat washer and nut from kit (shown in Figure 4), then position high pressure hose as shown. Tighten hose securely.
9. Remove low pressure hose from Power Steering pump. Quickly install new low pressure hose (from kit) to pump. Cap other end of new hose and end of old hose to prevent loss of fluid. Secure new hose to pump with original clamp.

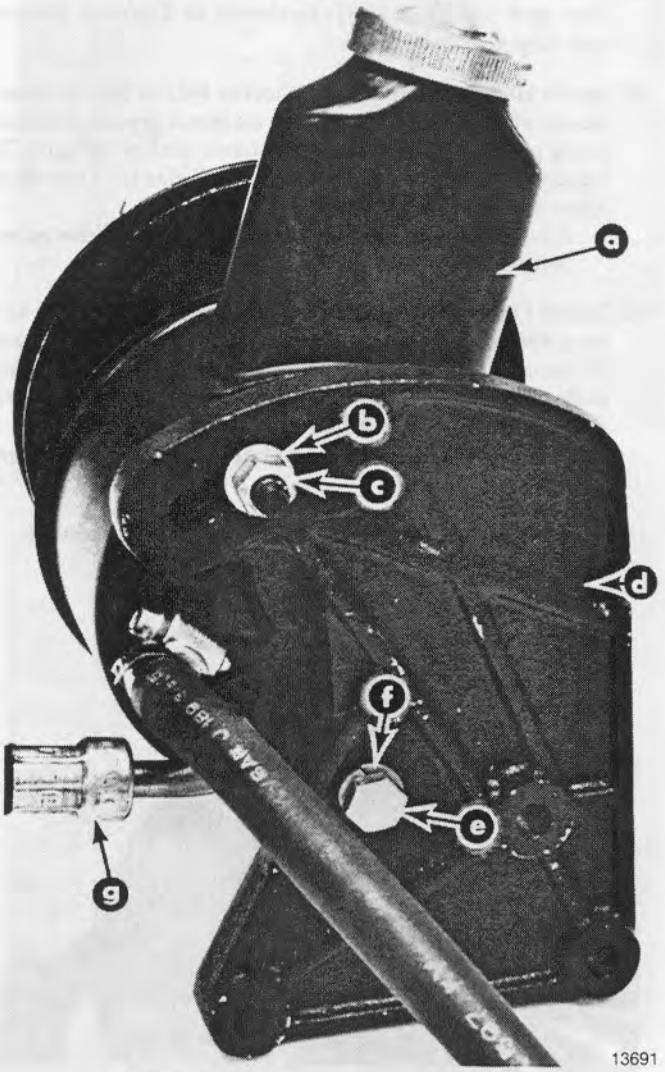
10. Remove J-clamp from engine block. Install Power Steering pump and mounting bracket to engine block, using three ⅜"-16 x 1½" (38mm) bolts and lockwashers from kit (shown in Figure 5). Be sure to reinstall J-clamp on mounting bracket as shown.
11. Route new low pressure hose under the front of the thermostat housing and under starboard exhaust manifold to oil cooler.
12. Remove old low pressure hose from fluid cooler and quickly connect new hose to cooler. Secure hose with original hose clamp.



13690

a - Large Center Bolt
b - Star Washer
c - Flat Washer
d - Bolts and Lockwashers (Retianed in Step 4)
e - Bolts and Lockwashers (Retained in Step 6)

Figure 3. Crankshaft and Circulating Pump Pulleys Installed



13691

a - Power Steering Pump
b - Flat Washer (from Kit)
c - Nut (from Kit)
d - Mounting Bracket
e - Bolt [3/8"-16 x 1-1/2" (38mm) Long; from Kit]
f - Lockwasher (from Kit)
g - High Pressure Hose

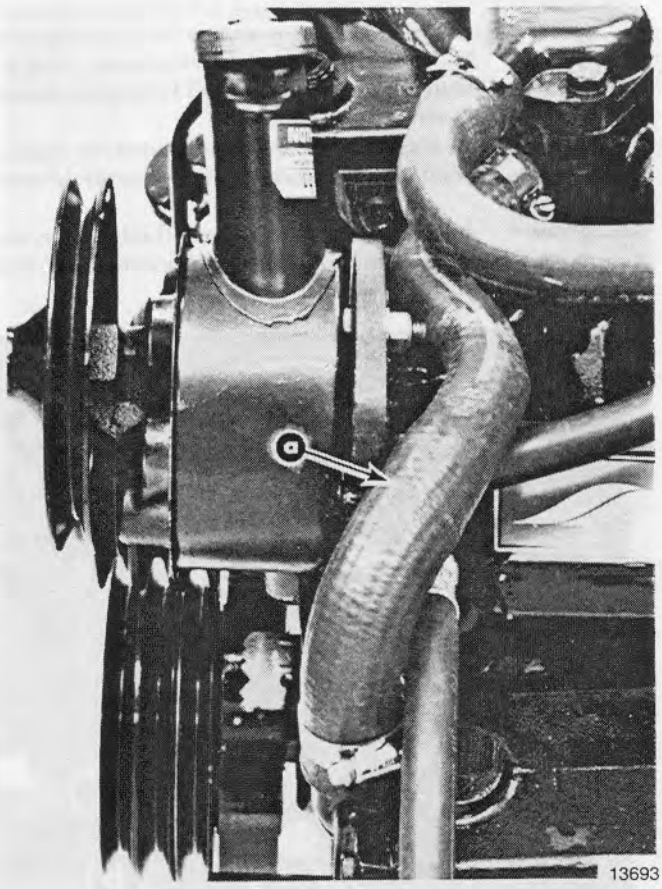
Figure 4. Installing Mounting Bracket on Power Steering Pump

13. Install new hose [thermostat housing to exhaust manifold front end cap (from kit)], as shown in Figure 6. Secure with original hose clamps.

14. Install alternator drive belt (shorter belt in kit) on inner groove of the crankshaft pulley, on inner groove of circulating pump pulley and on alternator pulley. (Figure 7) Adjust belt tension to specifications. (Refer to "Drive Belt Adjustment" in this section.)
    a. After belt adjustments are made, tighten all fasteners securely.

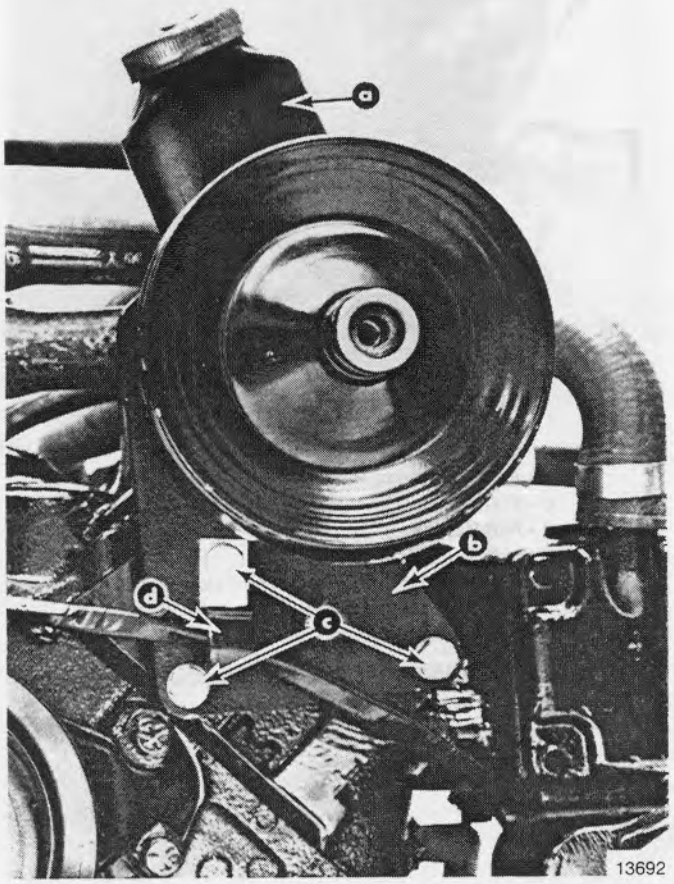
15. Install Power Steering pump drive belt (longer belt in kit) on outer groove of the crankshaft pulley, on outer groove of circulating pump pulley and on Power Steering pump pulley. (Figure 7) Adjust belt tension to specifications (Refer to "Drive Belt Adjustment" in this section.)
    a. After adjustments are completed, tighten all fasteners securely.

16. Follow Filling and Bleeding procedures in this section.



a - Hose

Figure 6. Thermostat Housing to Front End Cap Hose Installed



a - Power Steering Pump
b - Mounting Bracket
c - Bolts [3/8"-16 x 1-1/2" (38mm) Long] and Lockwashers (from Kit)
d - J-Clamp

Figure 5. Power Steering Pump Installed on Engine

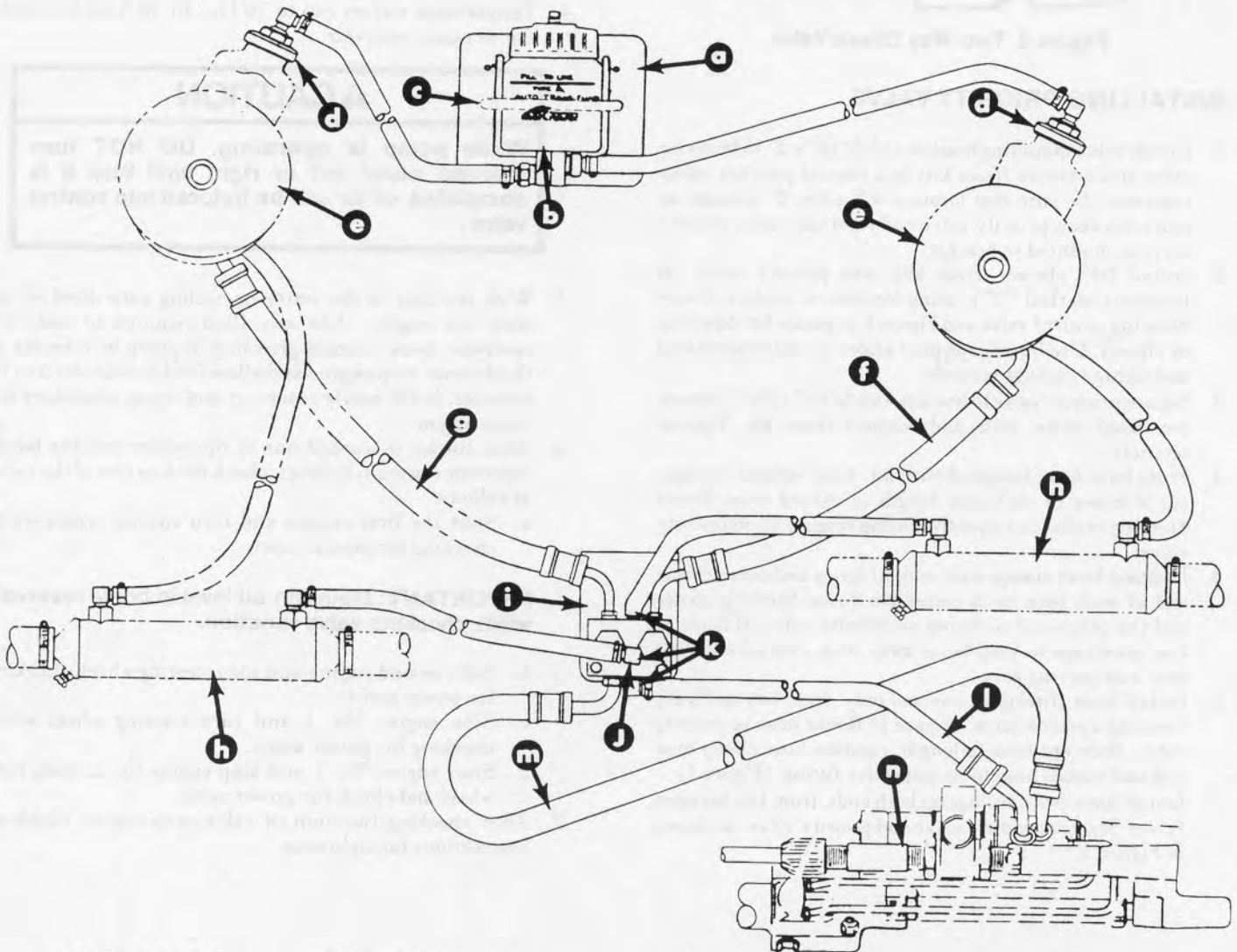
PRIORITY VALVE KIT (79691A1)

IMPORTANT: This kit is for use on dual installations where both engines are equipped with power steering pumps, coolers, related hardware and hoses and one transom assembly is equipped with power steering.

INSTALLING RESERVOIR

1. Mount reservoir bracket (Figure 1) to transom with 2 screws (from kit) halfway between the 2 Power Steering pumps in a location that affords both accessibiltiy and visual inspection of reservoir oil level. Be sure that location is at least 6" (15.2cm) higher than pump and is far enough away from any obstruction that might prevent mounting of priority valve. Priority valve must be mounted no closer than 2" (51mm) from bottom of reservoir.
2. Position bottle reservoir in mounting bracket and secure with retainer spring from kit.

IMPORTANT: The two-way check valve (Figure 2) is required for cold weather operation below 40° F (4° C). Remove vent from cover and replace with two-way check valve, if conditions require. (It is not necessary to replace vent if temperature is above 40° F (4° C), unless reservoir overflow during operation.)



a - Reservoir Bracket
b - Bottle Reservoir
c - Retainer Spring
d - Cap Assemblies
e - Power Steering Pumps
f - Secondary Pressure Line
g - Primary Pressure Line
h - Coolers
i - Priority Valve Bracket
j - Priority Valve
k - 90° Elbows
l - Return Hose from Kit
m - Pressure Hose from Kit
n - Power Steering Control Valve

Figure 1. Priority Valve Kit

3. From bulk hose (supplied with kit; hose without fitting), cut 2 hoses of sufficient length to extend from bottom of reservoir to fill caps on pumps. (Figure 1) Allow enough extra hose for routing and installation of cap assemblies.
4. Secure hoses with sta-straps to keep them below reservoir and away from excessive engine heat and moving parts.
5. Position hose clamps over ends of hoses, connect one end of each hose to reservoir and other end of each hose to a cap assembly. (Figure 1) Tighten hose clamps securely. DO NOT fasten caps to pumps at this time.

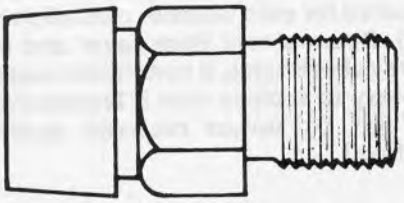


Figure 2. Two-Way Check Valve

INSTALLING PRIORITY VALVE

1. Install valve mounting bracket with 5/16" x 2" (51mm) lag bolts and washers (from kit) in a central position under reservoir. Be sure that location will allow 2" (51mm) or more between priority valve and reservoir when priority valve is mounted to bracket.
2. Install 90° elbows (from kit) into priority valve (at locations marked "T"), using location of coolers, Power Steering control valve and Figure 1 as guides for direction of elbows. Use liquid pipe joint sealer to seal connections and tighten fittings securely.
3. Secure priority valve to bracket with 5/16" x 2¾" (70mm) hex head bolts, nuts and washers from kit. Tighten securely.
4. From bulk hose (supplied with kit; hose without fitting), cut 2 hoses of sufficient length to extend from Power Steering cooler to respective fitting (Figure 1) on priority valve.
5. Position hose clamps over ends of hoses and connect one end of each hose to its respective Power Steering cooler and the other end to fitting on priority valve. (Figure 1) Use sta-straps to keep hoses away from excessive engine heat and moving parts.
6. Install hose (fitting on one end only, from kit) to Power Steering control valve. (Figure 1) Route hose to priority valve, then cut hose to length, position hose clamp over end and install hose to its respective fitting. (Figure 1)
7. Install hose (with fittings on both ends, from kit) between Power Steering control valve and priority valve, as shown in Figure 1.
8. Install both pressure hoses (leading from pumps) to locations on priority valve, as shown in Figure 1.

FILLING SYSTEM with FLUID

1. Remove shipping caps from pump reservoir (if not already removed) and fill reservoirs with Automatic Transmission Fluid (ATF), Dexron, or Dexron II.
2. Install caps (from kit) on pump reservoir so that after twisting each cap 120°, the fitting (hose) is facing forward (away from engine block).
3. Fill bottle reservoir to full mark, then (one at a time) twist and remove caps (hold cap above pump reservoir). Allow fluid to flow through line into pump reservoir. When pump reservoir is close to overflowing, reinstall cap as described in Step 2. Fill bottle reservoir and repeat process for other cap.
4. Torque large nut on cap to 70 Lbs. In. (8 N.m) to secure cap to pump reservoir.

⚠CAUTION

While pump is operating, DO NOT turn steering wheel left or right until Step 5 is completed, or air will be induced into control valve .

5. With the boat in the water or cooling water hooked up, start one engine. Add any fluid required to maintain reservoir level. Should growling in pump or foaming of fluid occur, stop engine and allow fluid to settle for 5 to 10 minutes. Refill bottle reservoir and repeat procedure for other engine.
6. After the air is worked out of the system and the bottle reservoir maintain its level, check the function of the valve as follows:
   a. Start the first engine and turn steering wheel while checking for power assist.

   IMPORTANT: Maintain oil level in bottle reservoir while checking valve function.

   b. Start second engine and turn steering wheel, checking for power assist.
   c. Stop engine No. 1 and turn steering wheel while checking for power assist.
   d. Start engine No. 1 and stop engine No. 2, then turn wheel and check for power assist.
7. After checking function of valve, stop engine; check all connections for tightness.